SIMPLEServo®

S900

MODEL 94 USERS MANUAL

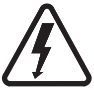
S94S01D

This document printed in the United States of America

Table of Contents

Safety Information

All safety information given in these Operating Instruction have the same layout:



Signal Word! (characterises the severity of the danger)

Note (describes the danger and informs on how to proceed)

Icon		Signal Words	
	Warning of hazardous electrical voltage	**DANGER!**	Warns of **impending danger**. Consequences if disregarded: Death or severe injuries.
	Warning of a general danger	**WARNING!**	Warns of **potential, very hazardous situations**. Consequences if disregarded: Death or severe injuries.
	Warning of damage to equipment	**STOP!**	Warns of **potential damage to material and equipment**. Consequences if disregarded: Damage to the controller/drive or its environment.
	Information	**Note**	Designates a general, useful note. If you obsserve it, handling the controller/ drive system is made easier.

1 General Information

The SimpleServo line of advanced general purpose servo drives utilize the latest technology in power semiconductors and packaging. SimpleServo uses Field Oriented control to enable high quality motion.

The SimpleServo Model 94 is available in four mains (input power) configurations:

1. **400/480V** (nominal) three phase input. An external input mains (line) filter is available. These drives have the suffix “T4N”.
2. **120/240V** (nominal) Single Phase input with integrated input mains (line) filter, Actual input voltage can range from 80VAC to 264VAC. The maximum output voltage is approximately equal to the input voltage. These drives have the suffix “S2F”.
3. **120/240V** (nominal) Single or Three Phase input. Actual input voltage can range from 80VAC to 264VAC. The maximum output voltage is approximately equal to the input voltage. An external input mains (line) filter is available. These drives have the suffix “Y2N”.
4. **120V or 240V** (nominal) single phase input. When wired for ***Doubler mode*** (L1-N), the input is for 120V nominal only and can range from 45VAC to 132 VAC and the maximum output voltage is double the input voltage. When wired to terminals L1-L2/N, the input can range from 80 VAC to 264 VAC and the maximum output voltage is equal to the input voltage. These drives have the suffix “S1N”.

The SimpleServo will accept feedback from an incremental encoder (that includes Hall channel information) or from a resolver. It accepts commands from a variety of sources, including analog voltage, RS485 interface (PPP and Modbus RTU), CANopen interface, digital pulse train, and master encoder reference. The control will operate in current (torque), velocity, or position (step and direction / master encoder) modes.

The SimpleServo’s built-in RS-232 serial communications port and SimpleServo control program, MotionView, make programming extremely simple. In fact, you could be up and running in less than thirty minutes! MotionView’s real-time oscilloscope tool with a sweep time of 1mS - 500mS allows the display of critical data (including current and velocity profiles) in graphic form for analyses and optimum tuning.

The EPM (Electronic Programming Module) stores all drive setup and tuning information. This module can be removed from the drive and reinstalled, making field replacement of the SimpleServo extremely easy.

SimpleServo controls support Point-to-Point (PPP) and Modbus RTU over RS485 and CANopen (DS301) communication protocols.

SimpleServo supports incremental quadrature encoder or resolver feedback devices. A second encoder can also be supported in position and velocity modes.

1.1 About these Operating Instructions

- These Operating Instructions are provided to assist you in connecting and commissioning the Model 94 SimpleServo servo controller. Important safety instructions are contained in this document which must be observed.
- All persons working on and with the controller must have the Operating Instructions available and must observe the information and notes relevant for their work.
- The Operating Instructions must always be in a complete and perfectly readable state.

1.2 Scope of Supply

<table>
<tr><th>Scope of Supply</th><th>Important</th></tr>
<tr><td>
• 1 Model 94 Servo type E94S...
• 1 Users Manual (English)
• 1 MotionView CD ROM including
- configuration software
- Documentation (Adobe Acrobat)
</td><td>
After reception of the delivery, check immediately whether the scope of supply matches the accompanying papers. Lenze does not accept any liability for deficiencies claimed subsequently.
Claim
• visible transport damage immediately to the forwarder
• visible deficiencies / incompleteness immediately to your Lenze representative.
</td></tr>
</table>

1.3 Legal regulations

<table>
<tr><th rowspan="2">Identification</th><th>Nameplate</th><th>CE Identification</th><th>Manufacturer</th></tr>
<tr><td>Lenze controllers are unambiguously designated by the contents of the nameplate</td><td>In compliance with the EC Low-Voltage Directive</td><td>AC Technology Corp.
member of the Lenze Group
630 Douglas Street
Uxbridge, MA 01569 USA</td></tr>
<tr><td>Application as directed</td><td colspan="3">
E94S… servo controller
• must only be operated under the conditions prescribed in these Instructions.
• are components
- for closed loop control of variable speed and torque applications with PM synchronous motors
- for installation in a machine.
- for assembly with other components to form a machine.
• are electric units for the installation into control cabinets or similar enclosed operating housing.
• comply with the requirements of the Low-Voltage Directive.
• are not machines for the purpose of the Machinery Directive.
• are not to be used as domestic appliances, but only for industrial purposes.
Drive systems with E94S… servo inverters
• comply with the EMC Directive if they are installed according to the guidelines of CE-typical drive systems.
• can be used
- for operation on public and non-public mains
- for operation in industrial premises and residential areas.
• The user is responsible for the compliance of his application with the EC directives.
Any other use shall be deemed as inappropriate!
</td></tr>
<tr><td>Liability</td><td colspan="3">
• The information, data, and notes in these instructions met the state of the art at the time of publication. Claims on modifications referring to controllers which have already been supplied cannot be derived from the information, illustrations, and descriptions.
• The specifications, processes and circuitry described in these instructions are for guidance only and must be adapted to your own specific application. Lenze does not take responsibility for the suitability of the process and circuit proposals.
• The specifications in these Instructions describe the product features without guaranteeing them.
• Lenze does not accept any liability for damage and operating interference caused by:
- Disregarding the operating instructions
- Unauthorized modifications to the controller
- Operating errors
- Improper working on and with the controller
</td></tr>
<tr><td>Warranty</td><td colspan="3">
• Warranty conditions: see Sales and Delivery Conditions of Lenze Drive Systems GmbH.
• Warranty claims must be made to Lenze immediately after detecting the deficiency or fault.
• The warranty is void in all cases where liability claims cannot be made.
</td></tr>
<tr><td rowspan="4">Disposal</td><td>Material</td><td>recycle</td><td>dispose</td></tr>
<tr><td>Metal</td><td>•</td><td>-</td></tr>
<tr><td>Plastic</td><td>•</td><td>-</td></tr>
<tr><td>Assembled PCB’s</td><td>-</td><td>•</td></tr>
</table>

2 Specifications

2.1 Electrical Characteristics

Single-Phase Models

Type	Mains Voltage (1)	1~ Mains Current (doubler)	1~ Mains Current (Std.)	Rated Output Current (4)	Peak Output Current (5)
E94S020S1N	**120V(2) or 240V(3)**	9.7	5.0	2.0	6
E94S040S1N		16.8	8.6	4.0	12
E94S020S2F	**120 / 240V(3)** (80 V -0%...264 V +0%)	--	5.0	2.0	6
E94S040S2F		--	8.6	4.0	12
E94S080S2F		--	15.0	8.0	24
E94S100S2F		--	18.8	10.0	30

Single/Three-Phase Models

Type	Mains Voltage (1)	1~ Mains Current	3~ Mains Current	Rated Output Current (4)	Peak Output Current (5)
E94S020Y2N	**120 / 240V(3) 1~ or 3~** (80 V -0%...264 V +0%)	5.0	3.0	2.0	6
E94S040Y2N		8.6	5.0	4.0	12
E94S080Y2N		15.0	8.7	8.0	24
E94S100Y2N		18.8	10.9	10.0	30
E94S020T4N	**400 / 480V 3~** (320 V -0%...528 V +0%)	--	2.7	2.0	6
E94S040T4N		--	5.5	4.0	12
E94S050T4N		--	6.9	5.0	15

(1) Mains voltage for operation on 50/60 Hz AC supplies (48 Hz -0% … 62Hz +0%).
(2) Connection of 120VAC (45 V … 132 V) to input power terminals L1 and N on these models doubles the voltage on motor output terminals U-V-W for use with 230VAC motors.
(3) Connection of 240VAC or 120VAC to input power terminals L1 and L2 on these models delivers an equal voltage as maximum to motor output terminals U-V-W allowing operation with either 120VAC or 230VAC motors.
(4) Drive rated at 8kHz Carrier Frequency. Derate Continuous current by 17% at 16kHz.
(5) Peak RMS current allowed for up to 2 seconds. Peak current rated at 8kHz. Derate by 17% at 16kHz.

Applies to all models:

Acceleration Time Range (Zero to Max Speed)	0.1 … 5×10^6 RPM/sec
Deceleration Time Range (Max Speed to Zero)	0.1 … 5×10^6 RPM/sec
Speed Regulation (typical)	± 1 RPM
Input Impedance (AIN+ to COM and AIN+ to AIN-)	47 kΩ
Power Device Carrier Frequency (sinusoidal commutation)	8,16 kHz
Encoder power supply (max)	+5 VDC @ 300 mA
Maximum encoder feedback frequency	2.1 MHz (per channel)

2.2 Environment

Vibration	2 g (10 - 2000 Hz)
Ambient Operating Temperature Range	0 to 40ºC
Ambient Storage Temperature Range	-10 to 70ºC
Temperature Drift	0.1% per ºC rise
Humidity	5 - 90% non-condensing
Altitude	1500 m/5000 ft [derate by 1% per 300m (1000 ft) above 1500m (5000 ft)]

2.3 Operating Modes

Torque

Reference	± 10 VDC 16-bit; scalable
Torque Range	100:1
Current-Loop Bandwidth	Up to 3 kHz

Velocity

Reference	± 10 VDC or 0…10 VDC; scalable
Regulation	± 1 RPM
Velocity-Loop Bandwidth	Up to 400 Hz
Speed Range	5000:1 with 5000 ppr encoder

Position

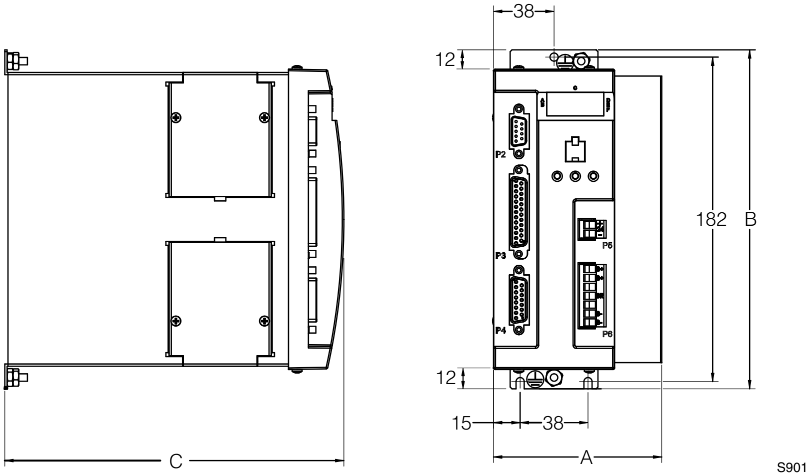
Reference	0…2 MHz Step and Direction or 2 channels quadrature input; scalable
Minimum Pulse Width	500 nanoseconds
Loop Bandwidth	Up to 200 Hz
Accuracy	±1 encoder count

2.4 Connections and I/O

RS232 serial interface	Standard 9-pin D-shell (DCE) (P2)
Encoder Feedback (primary)	Standard 15-pin D-shell (P4)
Encoder Feedback (secondary)	Option module with standard 9-pin D-shell (P12)
Resolver feedback	Option module with standard 9-pin D-shell (P11)
Encoder buffered repeat	In 25-pin D-shell controller connector (P3)
Mains Power	4-pin removable terminal block) (P1)
Motor Power	6-pin pin removable terminal block (P7)
Regen and Bus Power	5-pin removable terminal block (P6)
“Keep Alive” 24VDC Power	2-pin removable terminal block (P5)
Digital Inputs	1 dedicated (ENABLE), 1 programmable (5-24V) (P3)
Digital Outputs	2 programmable (5-24V @ 100mA) (P3)
Analog Input	1 differential; ±10 VDC (16-bit). (P3)
Analog Output	1 single ended; ±10 VDC (10-bit). (P3)
I/O Controller	Standard 25-pin D-shell. (P3)
Windows® Software:	MotionView (Windows 98, NT, 2000, XP)

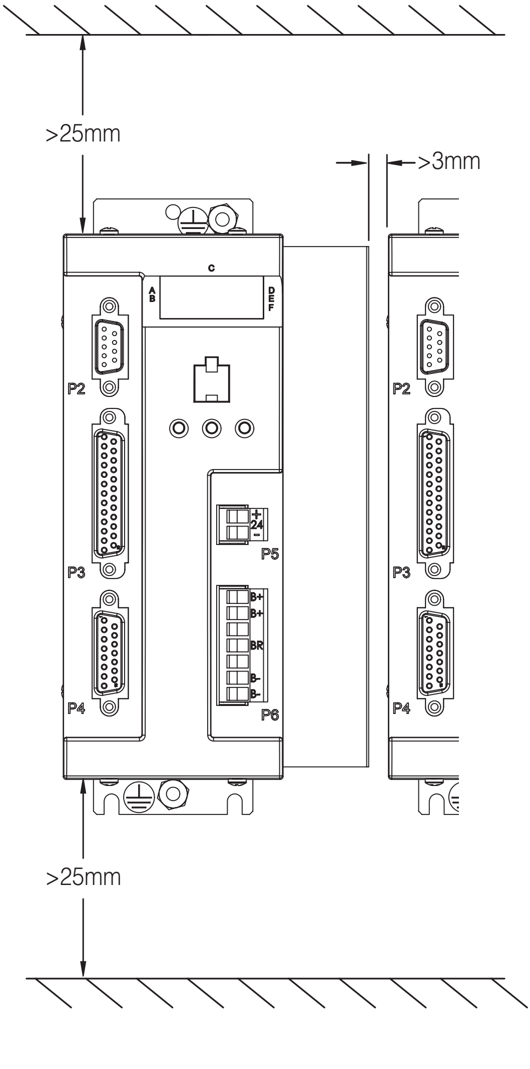
3 Dimensions

3.1 Model 94 Dimensions



Type	A (mm)	B (mm)	C (mm)	Weight (kg)
E94S020S1N	67	190	235	1.5
E94S040S1N	69	190	235	1.6
E94S020S2F	67	190	235	1.3
E94S040S2F	69	190	235	1.5
E94S080S2F	95	190	235	1.9
E94S100S2F	115	190	235	2.2
E94S020Y2N	67	190	190	1.3
E94S040Y2N	69	190	190	1.5
E94S080Y2N	95	190	190	1.9
E94S100Y2N	115	190	190	2.2
E94S020T4N	69	190	190	1.5
E94S040T4N	95	190	190	1.9
E94S050T4N	115	190	190	2.2

3.2 Clearance for Cooling Air Circulation



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4 Installation

Perform the minimum system connection. Please refer to section 8.1 for minimum connection requirements. Observe rules and warnings below:

DANGER!

- Hazard of electrical shock! Circuit potentials are up to 480 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing drive. Capacitors retain charge after power is removed.

STOP!

- The SimpleServo must be mounted vertically for safe operation at the maximum current rating.
- Printed circuit board components are sensitive to electrostatic fields. Avoid contact with the printed circuit board directly. Hold the SimpleServo by the case only.
- Protect the control from dirt, filings, airborne particles, moisture, and accidental contact. Provide sufficient room for access to the terminal block.
- Mount the control away from other heat sources. Operate within the specified ambient operating temperature range. Additional cooling with an external fan may be recommended in certain applications.
- Avoid excessive vibration to prevent intermittent connections
- DO NOT connect incoming (mains) power to the output motor terminals (U, V, W)! Severe damage to the SimpleServo will result.
- Do not disconnect any of the motor leads from the SimpleServo unless (mains) power is removed. Opening any one motor lead may cause failure.

4.1 Wiring

DANGER!

- Hazard of electrical shock! Circuit potentials are up to 480 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing the drive. Capacitors retain charge after power is removed.

STOP!

- Under no circumstances should power and control wiring be bundled together. Induced voltage can cause unpredictable behavior in any electronic device, including motor controls.

Refer to section 5.1.1 for Power wiring specifications..

4.2 Shielding and grounding

4.2.1 General guidelines

Lenze recommends the use of single-point grounding (SPG) for panel-mounted controls. Serial grounding (a “daisy chain”) is not recommended. The SPG for all enclosures must be tied to earth ground at the same point. The system ground and equipment grounds for all panel-mounted enclosures must be individually connected to the SPG for that panel using 14 AWG (2.5 mm^2) or larger wire.

In order to minimize EMI, the chassis must be grounded to the mounting. Use 14 AWG (2.5 mm^2) or larger wire to join the enclosure to earth ground. A lock washer must be installed between the enclosure and ground terminal. To ensure maximum contact between the terminal and enclosure, remove paint in a minimum radius of 0.25 in (6 mm) around the screw hole of the enclosure.

Lenze recommends the use of the special SimpleServo cables provided by Lenze. If you specify cables other than those provided by Lenze, please make sure all cables are shielded and properly grounded.

It may be necessary to earth ground the shielded cable. Ground the shield at the SimpleServo end and at the motor end.

If the SimpleServo continues to pick up noise after grounding the shield, it may be necessary to add an AC line filtering device and/or an output filter (between drive and servo motor).

EMC

Compliance with EN 61800-3/A11

This is a product of the restricted sales distribution class according to IEC 61800-3. In a domestic environment this product may cause radio interference in which the user may be required to take adequate measures

Noise emission

Drive Models ending in the suffix “2F” are in compliance with class A limits according to EN 55011 if installed in a control cabinet and the motor cable length does not exceed 10m. Models ending in “N” will require an appropriate line filter.

A Screen clamps

B Control cable

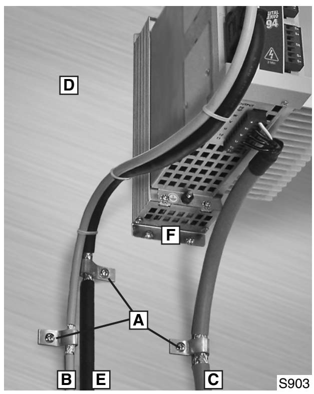
C Low-capacitance motor cable
(core/core < 75 pF/m, core/screen < 150 pF/m)

D Earth grounded conductive mounting plate

E Encoder Feedback Cable

F Footprint Filter (optional)

Installation according to EMC Requirements



4.2.2 EMI Protection

Electromagnetic interference (EMI) is an important concern for users of digital servo control systems. EMI will cause control systems to behave in unexpected and sometimes dangerous ways. Therefore, reducing EMI is of primary concern not only for servo control manufacturers such as Lenze, but the user as well. Proper shielding, grounding and installation practices are critical to EMI reduction.

4.2.3 Enclosure

The panel in which the SimpleServo is mounted must be made of metal, and must be grounded using the SPG method outlined in section 4.2.1.

Proper wire routing inside the panel is critical; power and logic leads must be routed in different avenues inside the panel.

You must ensure that the panel contains sufficient clearance around the drive. Refer to Section 3.2 suggested cooling air clearance.

4.3 Line filtering

In addition to EMI/RFI safeguards inherent in the SimpleServo design, external filtering may be required. High frequency energy can be coupled between the circuits via radiation or conduction. The AC power wiring is one of the most important paths for both types of coupling mechanisms. In order to comply with EN50081-1 and EN50082-2, an appropriate filter must be installed within 20cm of the drive power inputs.
Line filters should be placed inside the shielded panel. Connect the filter to the incoming power lines immediately after the safety mains and before any critical control components. Wire the AC line filter as close as possible to the SimpleServo. If you add separate fuses, add them after the AC line filter.

> **Note**
>
> The ground connection from the filter must be wired to solid earth ground, not machine ground.

If the end-user is using a CE-approved motor, the AC filter combined with the recommended SimpleServo motor and encoder cables, is all that is necessary to meet the EMC directives listed herein. The end user must use the compatible filter to comply with CE specifications. The OEM may choose to provide alternative filtering that encompasses the SimpleServo and other electronics within the same panel. The OEM has this liberty because CE is a machinery directive.

4.4 Heat sinking

SimpleServos contain sufficient heat sinking within the specified ambient operating temperature in their basic configuration. There is no need for additional heat sinking. However, you must ensure that there is sufficient clearance to circulate air. As a minimum, you must allow an air gap of 25 mm above and below the drive.

4.5 Line (Mains) fusing

External line fuses must be installed on all SimpleServo drives. Connect the external line fuse in series with the AC line voltage input. Use fast-acting fuses rated for 250 VAC or 600 VAC (depending on model), and approximately 200% of the maximum RMS phase current.

5 SimpleServo Connections

The standard SimpleServo control contains seven connectors: four quick-connect terminal blocks and three subminiature type “D” connectors. These connectors provide power, communications and external feedback to the motor, SimpleServo control, and host controller. Prefabricated cable assemblies may be purchased from Lenze to facilitate wiring the control, motor and host computer. Contact your SimpleServo Sales Representative for assistance.

As this manual makes reference to specific pins on specific connectors, we will use the convention PX.Y where X is the connector number and Y is the pin number.

5.1 External Connectors

5.1.1 P1 & P7 - Input Power and Output Power Connections

P1 is a 3 or 4-pin quick-connect terminal block used for input (mains) power. P7 is a 6-pin quick-connect terminal block used for output power to the motor. P7 also has a thermistor (PTC) input for motor over-temperature protection. The tables below identify connector pin assignments.

DANGER!

- Hazard of electrical shock! Circuit potentials are up to 480 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing drive. Capacitors retain charge after power is removed.

STOP!

- DO NOT connect incoming power to the output motor terminals (U, V, W)! Severe damage to the SimpleServo will result..

All conductors must be enclosed in one shield and jacket around them. The shield on the drive end of the motor power cable should be terminated to the conductive machine panel using screen clamps as shown in section 4.2. The other end should be properly terminated at the motor shield. Feedback cable shields should be terminated in a like manner. Lenze recommends SimpleServo cables for both the motor power and feedback. These are available with appropriate connectors and in various lengths. Contact your SimpleServo representative for assistance.

Wire size

I < 8 A:	16 AWG (1.5 mm^2) or 14 AWG (2.5 mm^2)
8 A < I < 12 A	14 AWG (2.5 mm^2) or 12 AWG (4.0 mm^2)
I > 12 A:	12 AWG (4.0 mm^2)

P1 TERMINAL ASSIGNMENTS (INPUT POWER)

Standard Models		Doubler Models	
Terminal	Function	Terminal	Function
PE	Protective Earth (Ground)	PE	Protective Earth (Ground)
L1	AC Power in	N	AC Power Neutral (120V Doubler only)
L2	AC Power in	L1	AC Power in
L3	AC Power in (3~ models only)	L2/N	AC Power in (non-doubler operation)

P7 TERMINAL ASSIGNMENTS (OUTPUT POWER)

Terminal	Function
PE	Protective Earth (Chassis Ground)
W	Motor Power Out
V	Motor Power Out
U	Motor Power Out
T2	Thermistor (PTC) Input
T1	Thermistor (PTC) Input

5.1.2 P2 - Serial Communications Port

P2 is a 9-pin D-sub connector that is used to communicate with a host computer via standard RS-232 interface using a proprietary Point-to-Point Protocol (PPP). This port is present on all SimpleServo drives. All levels must be RS-232C compliant.

P2 PIN ASSIGNMENTS (COMMUNICATIONS)

Pin	Name	Function
1	RESERVED	
2	TX	RS-232 (transmit)
3	RX	RS-232 (receive)
4	RESERVED	
5	GND	Common
6	RESERVED	
7	RESERVED	
8	RESERVED	
9	RESERVED	

STOP!
Do not make any connection to Reserved pins!

Note
If you purchase serial cables from a third party, you must use a pass-through cable, not Null-Modem (not crossover)

5.1.3 P3 - Controller Interface

P3 is a 25-pin DB connector for interfacing to front-end controllers. It is strongly recommended that you use OEM cables to aid in satisfying CE requirements. Contact your SimpleServo representative for assistance.

P3 PIN ASSIGNMENTS (CONTROLLER INTERFACE)

Pin	Name	Function
1	BA+	Buffered Encoder Output: Channel A+ (1)
2	BA-	Buffered Encoder Output: Channel A- (1)
3	BB+	Buffered Encoder Output: Channel B+ (1)
4	BB-	Buffered Encoder Output: Channel B- (1)
5	BZ+	Buffered Encoder Output: Channel Z+ (1)
6	BZ-	Buffered Encoder Output: Channel Z- (1)
7	GND	Drive Logic Common
8	SHLD	Shield
9	+5V	+5V output (max. 300mA)
10	IN2	Digital Input #2 (Programmable)
11	MA+/Step+	Master Encoder A+ / Step+ input (2)
12	MA-/Step-	Master Encoder A- / Step- input (2)
13	MB+/Dir+	Master Encoder B+ / Direction+ input (2)
14	MB-/Dir-	Master Encoder B- / Direction- input (2)
15	OUT1-C	Programmable output #1 Collector
16	OUT1-E	Programmable output #1 Emitter
17	IN1	Digital Input #1 (Enable) (3)
18	IN_COM	Digital Input Common (3)
19	OUT2-C	Programmable output #2 Collector
20	OUT2-E	Programmable output #2 Emitter
21	AO	Programmable analog output ±10V (use with AG)
22	GND	Drive logic common
23	AIN+	Positive (+) of Analog signal input
24	AIN -	Negative (-) of Analog signal input
25	AG	Analog Common

(1) See Note 1, Section 5.1.7 - Connector and Wiring Notes
(2) See Note 2, Section 5.1.7 - Connector and Wiring Notes
(3) See Note 3, Section 5.1.7 - Connector and Wiring Notes

5.1.4 P4 - Motor Feedback / second loop encoder input

P4 is a 15-pin DB connector that contains connections for hall effect sensors and incremental encoder feedback. Refer to the P4 pin assignments table for the connector pin assignments. Encoder inputs on P4 have 26LS32 or compatible differential receivers for increased noise immunity. Inputs have all necessary filtering and line balancing components so no external noise suppression networks are needed.

All conductors must be enclosed in one shield and jacket around them. Lenze recommends that each and every pair (for example, EA+ and EA-) be twisted. In order to satisfy CE requirements, use of an OEM cable is recommended. Contact your SimpleServo representative for assistance.

The SimpleServo buffers encoder feedback from P4 to P3. Encoder Feedback channel A on P4, for example, is Buffered Encoder Output channel A on P3. The Hall sensors from the motor must be wired to the 15-pin connector (P4).

STOP!
Use only +5 VDC encoders. Do not connect any other type of encoder to the SimpleServo reference voltage terminals. When using a front-end controller, it is critical that the +5 VDC supply on the front-end controller NOT be connected to the +5 VDC supply on the SimpleServo, as this will result in damage to the SimpleServo.

Note
- SimpleServo encoder inputs are designed to accept differentially driven hall signals. Single-ended or open-collector type hall signals are also acceptable by connecting “HA+”, “HB+”, “HC+” and leaving “HA-,HB-,HC-” inputs unconnected. You do not need to supply pull-up resistors for open-collector hall sensors. The necessary pull-up circuits are already provided by the SimpleServo amplifier.
- Encoder connections (A, B, and Z) must be full differential. SimpleServo doesn’t support single-ended or open-collector type outputs from the encoder.
- An encoder resolution of 2000 PPR (pre-quadrature) or higher is recommended.

Using P4 as second encoder input for dual-loop operation.

P4 can be used as a second loop encoder input in situations where the motor is equipped with a resolver as the primary feedback. If such a motor is used, the drive must have a resolver feedback option module (E94ZARSV1) installed. A second encoder can then be connected to the A and B lines of the P4 connector for dual loop operation. See “Dual loop feedback operation” for details (Section 8.4).

P4 PIN ASSIGNMENTS (ENCODER)

Pin	Name	Function
1	EA+	Encoder Channel A+ Input
2	EA-	Encoder Channel A- Input
3	EB+	Encoder Channel B+ Input
4	EB-	Encoder Channel B- Input
5	EZ+	Encoder Channel Z+ Input
6	EZ-	Encoder Channel Z- Input
7	GND	Drive Logic Common/Encoder Ground
8	SHLD	Shield
9	PWR	Encoder supply (+5VDC)
10	HA-	Hall Sensor A- Input
11	HA+	Hall Sensor A+ Input
12	HB+	Hall Sensor B+ Input
13	HC+	Hall Sensor C+ Input
14	HB-	Hall Sensor B- Input
15	HC-	Hall Sensor C- Input

(1) See Note 1, Section 5.1.7 - Connector and Wiring Notes

5.1.5 P5 - 24 VDC Back-up Power Input

P5 is a 2-pin quick-connect terminal block that can be used with an external 24 VDC (2 amp) power supply to provide "Keep Alive" capability: during a power loss, the logic and communications will remain active. Applied voltage must be greater than 20VDC.

P5 TERMINAL ASSIGNMENTS (BACK-UP POWER)

Terminal	Function
+24 VDC	Positive 24 VDC Input
Return	24V power supply return

WARNING!
Hazard of unintended operation! The "Keep Alive" circuit will restart the motor upon restoration of mains power when the enable input remains asserted. If this action is not desired, the the enable input must be removed prior to reapplication of input power.

5.1.6 P6 - Braking Resistor and DC Bus

P6 is 5-pin quick-connect terminal block that can be used with an external braking resistor (the SimpleServo has the regen circuitry built-in). The Brake Resistor connects between the Positive DC Bus (either P6.1 or 2) and P6.3.

P6 TERMINAL ASSIGNMENTS (BRAKE RESISTOR AND DC BUS)

Terminal	Function
B+ B+	Positive DC Bus / Brake Resistor
BR	Brake Resistor
B- B-	Negative DC Bus

5.1.7 Connectors and Wiring Notes

Note 1
Each of the encoder output pins on P3 is a buffered pass-through of the corresponding input signal on P4. This can be either from a motor mounted (primary feedback) encoder or from an auxiliary encoder when a resolver is the primary feedback device on the motor.

Via software, these pins can be reprogrammed to be a buffered pass through of the signals from a feedback option card. This can be either the second encoder option module (E94ZAENC1) or an encoder emulation of the resolver connected to the resolver option module (E94ZARSV1).

Note 2
An external pulse train signal ("step") supplied by an external device, such as a PLC or stepper indexer, can control the speed and position of the servomotor. The speed of the motor is controlled by the frequency of the "step" signal, while the number of pulses that are supplied to the SimpleServo determines the position of the servomotor. "DIR" input controls direction of the motion.

Note 3
The ENABLE pin (IN1, P3.17) must be wired through a switch or an output on a front-end controller to digital input common (IN_COM, P3.18). If a controller is present, it should supervise the enable function on the SimpleServo. The SimpleServo ENABLE circuit will accept 5-24V control voltage.

5.1.8 P11 - Resolver interface module (Option Bay 2)

SimpleServo drives can operate motors equipped with resolvers. Resolver connections are made to a 9 pin D-shell female connector (P11) on the resolver option module (E94ZARSV1). When the motor profile is loaded from the motor database or from a custom motor file, the drive will select the primary feedback source based on the motor data entry.

When using a Lenze motor with resolver feedback and a Lenze resolver cable, the pins are already configured for operation. If a non-Lenze motor is used, the resolver connections are made as follows:

P11 PIN ASSIGNMENTS (Resolver Feedback)

Pin	Name	Function
1	Ref +	Resolver reference connection
2	Ref -	
3	N/C	No Connection
4	Cos+	Resolver Cosine connections
5	Cos-	
6	Sin+	Resolver Sine connections
7	Sin-	
8	PTC+	Thermal sensor
9	PTC-	

STOP!
Use only 10 V (peak to peak) or less resolvers. Use of higher voltage resolvers may result in feedback failure and damage to the resolver option module.

5.1.9 P12 - Second encoder interface module (Option Bay 2)

SimpleServo drives can support a second incremental encoder interface for dual-loop systems. Depending on the motor primary feedback type (encoder or resolver) a second encoder can be connected as follows:

- If the primary motor feedback is an encoder (connected to P4), the second encoder interfaces through the encoder option module (E94ZAENC1) at P12 on Option Bay 2.
- If the motor primary feedback is a resolver connected to the resolver option module (E94ZARSV1) at P11 on Option Bay 2, the second encoder connects to the P4 connector on the drive. In this case, the hall inputs on P4 are not used.

The 2nd Encoder Option Module includes a 9 pin D-shell male connector. When using a Lenze motor with encoder feedback and a Lenze encoder cable, the pins are already configured for operation. If a non-Lenze motor is used, the encoder connections are made as follows:

P12 PIN ASSIGNMENTS (Second Encoder Feedback)

Pin	Name	Function
1	E2B+	Second Encoder Channel B+ Input
2	E2A-	Second Encoder Channel A- Input
3	E2A+	Second Encoder Channel A+ Input
4	+5v	Supply voltage for Second Encoder
5	COM	Supply common
6	E2Z-	Second Encoder Channel Z- Input
7	E2Z+	Second Encoder Channel Z+ Input
8	N/C	No Connection
9	E2B-	Second Encoder Channel B- Input

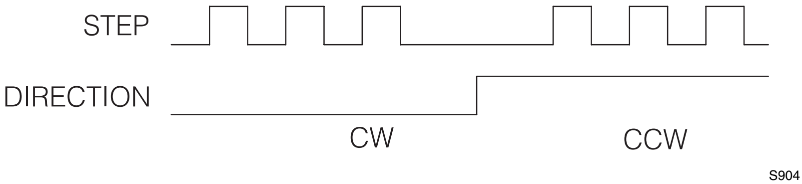
The second encoder needs to be enabled using MotionView software. See section “Dual-loop feedback” (Section 8.4) for details.

STOP!
Use only +5 VDC encoders. Do not connect any other type of encoder to the option module otherwise damage to drive’s circuitry may result.

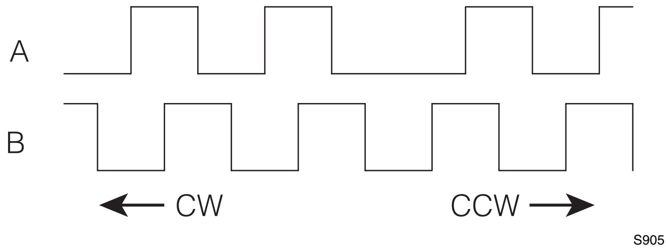
5.2 Digital I/O details

5.2.1 Step & Direction / Master Encoder Inputs (P3, pins 11-14)

You can connect a master encoder with quadrature outputs or a step and direction pair of signals to control position in step / direction operating mode (stepper motor emulation). These inputs are optically isolated from the rest of the drive circuits and from each other. Both inputs can operate from any voltage source in the range of 5 to 24 VDC and do not require additional series resistors for normal operation. See figure below.

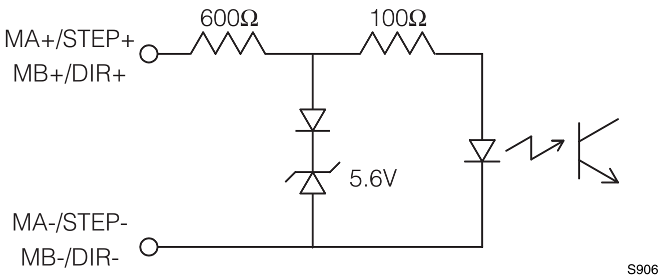


Timing characteristics for Step And Direction signals



Timing characteristics for Master Encoder signals

Input type/ output compatibility	Insulated, compatible with Single-ended or differential outputs (5-24 VDC)
Max frequency (per input)	2 MHz
Min pulse width (negative or positive)	500nS
Input impedance	700 Ω (approx)



Master encoder/step and direction input circuit.

You can connect a single ended or differential signal to the inputs. You can also connect sinking or sourcing outputs to these inputs. The function of these inputs "Master Encoder" or "Step and Direction" is software selectable. Use MotionView set up program to choose desirable function.

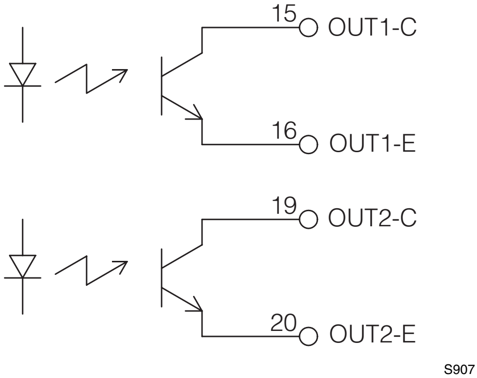
5.2.2 Digital outputs

There are two digital outputs ("OUT1" and "OUT2") available on P3. Outputs are fully isolated from the rest of the drive circuits ("dry contacts"). See figure below for its electrical diagram. Output polarity is programmable i.e. each output can be programmed for N.O. or N.C. operation. Each output can be assigned to one of the following functions:

- Zero speed
- In-speed window
- Current limit
- Run-time fault
- Ready
- Brake (motor brake release)

Digital outputs electrical characteristics

Circuit type	Isolated Open Collector
Digital outputs load capability	100mA
Digital outputs Collector-Emitter max voltage	30V



Digital outputs circuit.

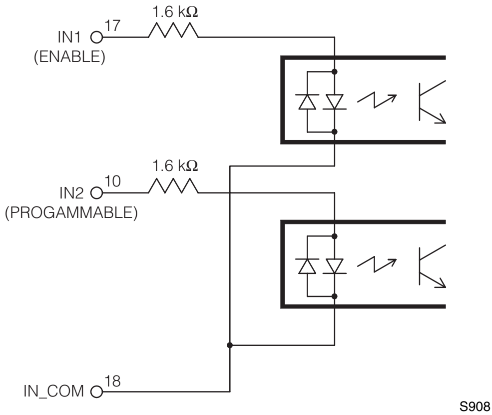
5.2.3 Digital inputs

IN1 and IN2 (P3.10, 17, and 18).

Optically isolated inputs. Inputs IN1 and IN2 are compatible with a 5 -24V voltage source . No additional series resistor is needed for circuit operation. Both inputs share COM terminal IN_COM. Input IN1 is dedicated for “Drive Enable” function while IN2 is programmable. Choices are:

- External fault
- Stop (rapid)
- Reverse reference

In addition both inputs have separate software adjustable de-bounce time.



Digital inputs circuit.

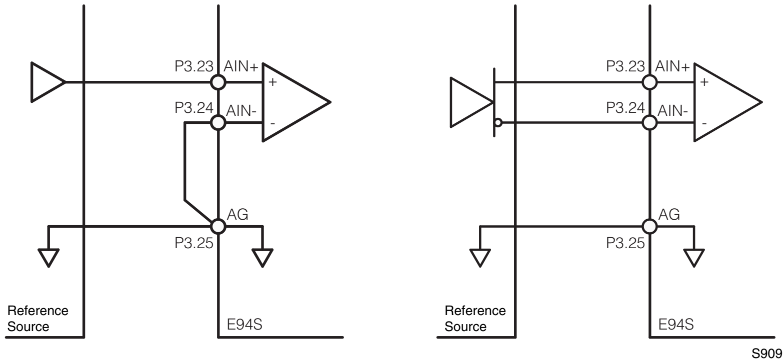
5.3 Analog I/O details

5.3.1 Analog reference input

AIN+, AIN- (P3.23 and P3.24)

The analog reference input can accept up to a ±10V analog signal across AIN+ and AIN-. The maximum limit with respect to analog common (AG) on each input is ±18VDC. The analog signal will be converted to a digital value with 16 bit resolution (15 bit plus sign). This input is used to control speed or torque of the motor in velocity or torque mode. The total reference voltage as seen by the drive is the voltage difference between AIN+ and AIN-. If used in single-ended mode, one of the inputs must be connected to a voltage source while the other one must be connected to Analog Common (AG). If used in differential mode, the voltage source is connected across AIN+ and AIN- and the driving circuit common (if any) needs to be connected to the drive Analog Common (AG) terminal.

Reference as seen by drive: Vref = (AIN+) - (AIN-) and -10V <= Vref <= +10V



Single-ended **Differential**

5.3.2 Analog output

AO (P3.21)

Analog output is a single-ended signal (with reference to Analog Common (AG) which can represent the following Motor data:

- RMS Phase Current
- Peak Phase Current
- Motor Velocity
- Phase U Current
- Phase V Current
- Phase W Current

MotionView Setup program can be used to select the signal source for the analog output as well as its scaling.

5.4 Communication interfaces

5.4.1 RS232 interface (standard)

SimpleServo drives are equipped with RS232 communication interface as a standard for programming and diagnostics from MotionView Software. The E94S family of drives support the following baud rates: 9600, 19,200 and 38,400. Drives are addressable with up to 32 addresses from 0-31. Communication speed and address are set from the drive's front panel display.

5.4.2 P8 - RS485 interface module (Option Bay 1)

SimpleServo drives can be equipped with an RS485 communication interface option module (E94ZARS41) which is optically isolated from the rest of the drive's circuitry. This option module can be used for two functions: drive programming and diagnostics using MotionView from a PC (with RS485 port) or as a Modbus RTU slave. The E94S family of drives support the following baud rates: 9600, 19,200 and 38,400. Drives are addressable with up to 32 addresses from 0-31. The factory setting for the baud rate is 38,400 with a node address of "1". The drives address must be set from the front panel display of the drive. When used with MotionView software, the communication speed is also set from the front panel display. Please note that baud rate and address are applied to both RS232 and RS485 interfaces in this case. If used for Modbus RTU communications, the Modbus baud rate is set as a parameter within the MotionView.

P8 TERMINAL ASSIGNMENTS (RS485 interface)

Terminal	Function
ICOM	Isolated Common
TXB	Transmit A
TXA	Transmit B

5.4.3 Using RS232 and RS485 interfaces simultaneously

If a MotionView command is received by the drive and doesn't matched the drive's address, the drive resends this command over the other interface. For example if the drive receives the command over RS232 and the address does not match, the drive will resend this command over the RS485 interface thus making it available for another device on the network. The same will happen if a command is received over the RS485 interface; all devices whose addresses do not match will repeat the command on their RS232 ports. This feature is useful when you need to access drives on an RS485 network using an RS232 interface. Typically a PC is not equipped with an RS485 interface as standard. Using the above described feature, a PC can be used to communicate to an RS485 network of SimpleServo drives by connecting the PC's RS232 port to one of the drives in the network.

5.4.4 MODBUS RTU support

As a default, the RS232 and RS485 interfaces are configured to support MotionView program operation. In addition, the RS485 interface can be configured to support the MODBUS RTU slave protocol. The interface can be configured through the MotionView program. When configured for MODBUS operation, the baud rate for RS485 is set by the parameter "Modbus baud rate" in MotionView, while the RS232 baud rate is set on the drive's front panel. Thus RS485 and RS232 can have different speeds at the same time if RS485 is configured for MODBUS operation. Please note that if RS485 is configured for MODBUS operation, the command repeat function (see 5.4.3) is unavailable even if baud rates are set the same for both interfaces.

The Modbus RTU slave interface protocol definitions can be found in the MotionView help menu under "Product Manuals".

5.4.5 P9 - CAN bus interface module (Option Bay 1)

CANopen interface is available as an option module (E94ZACAN1). The CANopen interface support documentation can be found in the MotionView help menu under "Product Manuals".

P9 TERMINAL ASSIGNMENTS (CAN bus interface)

Terminal	Function
ICOM	Isolated Common
CANL	CAN bus Low
CANH	Can bus High

5.5 Motor Selection

SimpleServo drives are compatible with many 3-phase AC synchronous servo motors, both Lenze motors and motors from the other manufacturers. We have tested many motors with the SimpleServo and put their parameters in a database for customer convenience. If your motor is in the database, you do not need to provide any motor data to set it up. However, if your motor is not in the database, it can still be used, but some electrical and mechanical data will need to be provided to create a custom motor profile. The auto-phasing feature of the SimpleServo allows you to correctly determine the relationship between phase voltage and hall sensor signals, eliminating the need to use a multi-channel oscilloscope.

5.5.1 Motor connection.

Motor phase U, V, W (or R, S, T) are connected to terminal P7. It is very important that motor cable shield is connected to Earth ground terminal (PE) or the drive's case.

The motor feedback cable must be connected to encoder terminal P4 if the motor is equipped with an incremental encoder. If the motor is equipped with a resolver it needs to be connected to terminal P11 on the resolver option module (E94ZARSV1).

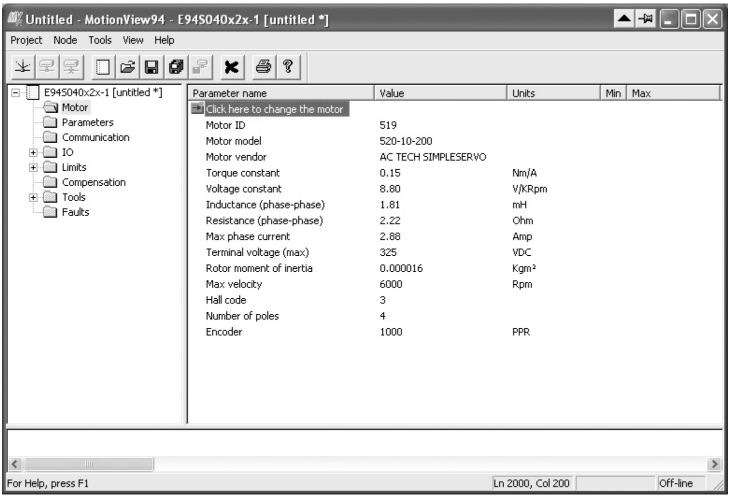
5.5.2 Motor over-temperature protection

If using a motor equipped with an encoder and PTC thermal sensor, the encoder feedback cable will have flying leads exiting the P4 connector to be wired to the P7.1 (T1) and P7.2 (T2) terminals. If using a motor equipped with a Resolver and a PTC sensor, the connector on the Resolver Option Module (P11) provides this connection.

Use parameter "Motor PTC cut-off resistance" (see section 6.3.12) to set the resistance which corresponds to maximum motor allowed temperature. The parameter "Motor temperature sensor" must also be set to ENABLE. If the motor doesn't have a PTC sensor, set this parameter to DISABLE. This input will also work with N.C. thermal switches which have only two states; Open or Closed. In this case "Motor PTC cut-off resistance" parameter can be set to the default value.

5.5.3 Setting Up motor

MotionView Motor Group on the left tree shows the currently selected motor. You can click “CLICK HERE TO CHANGE” to view selected motor parameters or select new motor.



S910

MotionView’s “Motor Group” folder and its contents

> **Note**
> If drive is ENABLED, a new motor cannot be set. You can only set a new motor when the drive is DISABLED.

To View selected motor parameters or make a new motor selection:

- Click “CLICK HERE TO CHANGE”. Selection dialog opens (see figure above). If you are just viewing motor parameters click Cancel on Motor Parameters dialog when done to dismiss the dialog box.
- Select motor Vendor from the right list box and desired motor from the left list box.
- If you will be using a “custom” motor (not listed in our motor database) go to ”Using a custom motor” topic in the next section.
- Finally click OK button to dismiss dialog and return to MotionView main program.

5.6 Using a custom motor

You can load a custom motor from a file or you can create a new custom motor.

- To create a custom motor click “CREATE CUSTOM” and follow the instructions in the next section “Creating custom motor parameters”.
- To load a custom motor click “OPEN CUSTOM” button then select the motor file and click the “OPEN“ button to select or “CANCEL“ to return to the previous dialog box.
- Click OK to load the motor data and return to the main MotionView menu or Cancel to abandon changes. When clicking OK for a custom motor, a dialog box will appear asking if you want to execute “Autophasing” (see section 5.6.2).

5.6.1 Creating custom motor parameters

STOP!
Use extreme caution when entering custom parameters! Incorrect settings may cause damage to the drive or motor! If you are unsure of the settings, refer to the materials that were distributed with your motor, or contact the motor manufacturer for assistance.

1. Enter custom motor data in the motor parameters dialog fields. Complete all sections of dialog: Electrical, Mechanical, Feedback. See Section 6.8.3 for explanation of motor parameters and how to enter them.

Note
If are unsure of the motor halls order and encoder channels A and B relationship, leave “B leads A for CW”, “Halls order” and “inverted” fields as they are. You can execute autophasing (see section 5.6.2) to set them correctly.

2. Enter motor model and vendor in the top edit boxes. Motor ID cannot be entered, this is set to 0 for custom motors.
3. Click Save to File button and enter filename without extension. Default extension .cmt will be given when you click OK on file dialog box.

Note
Saving the file is necessary even if you are going to use the autophasing feature and still don’t know all of the final parameters. After autophasing is completed you will have a chance to save the corrected motor file again before loading it to memory.

4. Click OK to exit from the Motor Parameters dialog.
5. MotionView will ask if you want to autophase your custom motor. If you answer “No”, the motor data will be loaded immediately to the drive’s memory. If you answer “Yes”, the motor dialog will be dismissed and the drive will start the autophasing sequence. Refer to section 5.6.2 for autophasing information.
6. If you answered “Yes” for autophasing, you will be returned to the same motor selection dialog box after autophasing is complete. For motors with incremental encoders, the fields “B leads A for CW”, “Halls order” and “inverted” will be assigned correct values. For motors with resolvers, the fields “Offset in degree” and “CW for positive” will be assigned correct values.
7. Click “Save File” to save the custom motor file and then “OK” to exit the dialog box and load the data to the drive.

5.6.2 Autophasing

The Autophasing feature determines important motor parameters when using a motor that is not in MotionView’s database. For motors equipped with incremental encoders, Autophasing will determine the Hall order sequence, Hall sensor polarity and encoder channel relationship (B leads A or A leads B for CW rotation). For motors equipped with resolvers, Autophasing will determine resolver angle offset and angle increment direction (“CW for positive”).

To perform autophasing:

1. Complete the steps in the previous section “Setting custom motor parameters”. If the motor file you are trying to autophase already exists, simply load it as described under “Using a custom motor” at the beginning of this section.

2. Make sure that the motor's shaft is not connected to any mechanical load and can freely rotate.

STOP!
Autophasing will energize the motor and will rotate the shaft.
Make sure that the motor's shaft is not connected to any mechanical load and can freely and safely rotate.

3. **Make sure that the drive is not enabled.**
4. It is not necessary to edit the field "Hall order" and check boxes "inverted" and "B leads A for CW" as these values are ignored for autophasing.
5. Click OK to dismiss motor selection dialog. MotionView responds with the question "Do you want to perform autophasing?"
6. Click OK. A safety reminder dialog appears. Verify that it is safe to run the motor then click "Proceed" and wait until autophasing is completed.

Note
If there was a problem with the motor connection, hall sensor connection or resolver connection, MotionView will respond with an error message. Common problems are with power, shield and ground terminations or an improper cable is being used.
Correct the wiring problem(s) and repeat steps 1 - 6.

If the error message repeats, exchange motor phases U and V (R and S) and repeat. If problems persist, contact the factory.

7. If autophasing is completed with no error then MotionView will return to the motor dialog box. For motors with incremental encoders, the parameter field "Hall order" and the check boxes "inverted", "B leads A for CW" will be filled in with correct values. For resolver equipped motors, fields "Offset " and "CW for positive" will be correctly set.
8. Click "Save File" to save the completed motor file (you can use the same filename as you use to save initial data in step 1) and click OK to load the motor data to the drive.

5.6.3 Custom Motor Data Entry

The Motor Parameters dialog has three sections (frames) dividing motor parameters into groups: Electrical constants, Mechanical constants, and Feedback. When creating a custom motor you must supply all parameters listed in these sections. All entries are mandatory except the motor inertia (Jm) parameter. A value of 0 may be entered for the motor inertia if the actual value is unknown.

5.6.3.1 Electrical constants

Motor Torque Constant (Kt).

Enter the value and select proper units from the drop-down list.

Note

Round the calculated result to 3 significant places.

Motor Voltage Constant (Ke).

The program expects Ke to be entered as a phase-to-phase Peak voltage. If you have Ke as an RMS value, multiply this value by 1.414 for the correct Ke Peak value.

Phase-to-phase winding Resistance (R) in Ohms (Ω).

This is also listed as the terminal resistance (Rt). The phase-to-phase winding Resistance (R) will typically be between 0.05 and 200 Ohms.

Phase-to-phase winding Inductance (L).

This must be set in millihenries (mH). The phase-to-phase winding Inductance (L) will typically be between 0.1 and 200.0 mH.

> **Note**
>
> If the units for the phase-to-phase winding Inductance (L) are given in micro-henries (µH), then divide by 1000 to get mH.

Nominal phase current (RMS Amps)

Nominal continuous phase current rating (In) in Amps RMS. Do not use the peak current rating.

> **Note**
>
> Sometimes the phase current rating will not be given. The equation below may be used to obtain the nominal continuous phase-to-phase winding current from other variables.
>
> **In= Continuous Stall Torque / Motor Torque Constant (Kt)**

The same force x distance units must be used in the numerator and denominator in the equation above. If torque (T) is expressed in units of pound-inches (lb-in) then, Kt must be expressed in pound-inches per Amp (lb-in/A). Likewise, if T is expressed in units of Newton-meters (N-m), then units for Kt must be expressed in Newton-meters per Amp (N-m/A).

Example:

Suppose that the nominal continuous phase to phase winding current (In) is not given. Instead, we look up and obtain the following:
Continuous stall torque T = 3.0 lb-in
Motor torque constant Kt = 0.69 lb-in/A
Dividing, we obtain:

In = 3.0 lb-in / 0.69 lb-in/A =4.35 (A)

Our entry for In would be 4.35. Note that the pound-inch (lb-in) units cancelled in the equation above leaving only Amps (A). We would have to use another conversion factor if the numerator and denominator had different force x distance units.

Nominal Bus Voltage (Vbus)

The Nominal Bus Voltage can be calculated by multiplying the Nominal AC mains voltage supplied by 1.41. When using a model with the suffix “S1N” where the mains are wired to the “Doubler” connection, the Nominal Bus Voltage will be doubled.

Example:

If the mains voltage is 230VAC, Vbus = 230 x 1.41 = 325V

This value is the initial voltage for the drive and the correct voltage will be calculated dynamically depending on the drive’s incoming voltage value.

Rotor Moment of Inertia (Jm)

From motor manufacturer or nameplate.

> **Note**
>
> Round the calculated result to 3 significant places.

Maximum Motor Speed in RPM

This is also listed as “Speed @ V_t” (motor speed at the terminal voltage rating). The maximum motor speed will typically be a round even value between 1000 and 6000 RPM.

Number of Poles

This is a positive integer number that represents the number of motor poles, which is normally 2, 4, 6 or 8.

5.6.3.2 For motors equipped with incremental encoders only:

Encoder Line Count

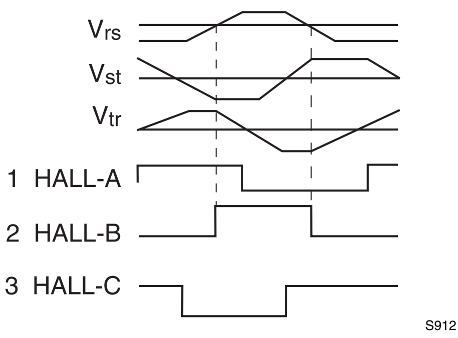
The Encoders for servomotors normally have Line Counts of 1000, 1024, 2000, 2048, 4000, or 4096. The Encoder Line Count must be a positive integer and must be pre-quadrature.

Index pulse offset. Enter 0 (zero)

Index marker pulse position. This field is reserved for backward compatibility. All SimpleServo drives determine actual marker pulse position automatically.

Halls Order

Each hall signal is in phase with one of the three phase-phase voltages from the motor windings. Hall order number defines which hall sensor matches which phase-phase voltage. Motor phases are usually called R-S-T or U-V-W or A-B-C. Phase-Phase voltages are called Vrs, Vst, Vtr. Halls are usually called HALL-A, HALL-B, HALL-C or just Halls 1, 2, 3. A motor’s phase diagram is supplied by motor vendor and usually can be found in the motor data sheet or by making a request to the motor manufacturer. A sample phase diagram is shown below.



The Halls Order is obtained as follows:

1. By looking at the “Vrs” Output Voltage, determine which Hall Voltage is lined up with (or in phase with) this voltage. We can determine which Hall Voltage is in phase with the Vrs Output Voltage by drawing vertical lines at those points where it crosses the horizontal line (zero). The dashed lines at the zero crossings (above) indicate that Hall B output is lined up with (and in phase with) the Vrs Output Voltage.
2. Look at the “Vst” Output Voltage. Determine which Hall Voltage is in phase with this Voltage. As can be seen, Hall C output is in phase with the Vst Output Voltage.
3. Look at the “Vtr” Output Voltage. Determine which Hall Voltage is in phase with this Voltage. As can be seen, Hall A output is in phase with the Vtr Output Voltage.

Note

If hall sensors are in phase with corresponding phase voltage but inverted 180 degrees (hall sensor waveform edge aligns with phase-phase voltage waveform but positive hall sensor cycle matches negative phase-phase waveform or visa-versa), you must check "Inverted" check box.

4. The phases that correspond to the Vrs Vst Vtr voltages are Hall B then Hall C then Hall A or halls number 2 then 3 then 1. Referring to the following table, we find that 2-3-1 sequence is Halls Order number 3. We would enter 3 for the Halls Order field in motor dialog.

HALL ORDER NUMBERS FOR DIFFERENT HALL SEQUENCES

Halls Order	Hall Sequence
0	1-2-3
1	1-3-2
2	2-1-3
3	2-3-1
4	3-1-2
5	3-2-1

Note

Each Hall Voltage will be in phase with one and only one Output Voltage.

B leads A for CW.

This is encoder phase relationship for CW/CCW shaft rotation. When you obtain the diagram for your motor phasing similar to shown above, it's assumed by software that motor shaft rotating CW when looking at the mounting face of the motor. For that rotation Encoder phase A must lead phase B. If it does leave check box unchecked. Otherwise (if B leads A) check B leads A for CW box.

Note

Some manufacturers' timing diagrams are CW when viewed from the "rear" of the motor (not from shaft!).

5.6.3.3 For resolver equipped motors only:

If parameter "Resolver" is checked, following parameters appear on the form:

Offset in degree (electrical)

This parameter represents offset between resolver's "0 degree" and motor's windings "0 degree".

CW for positive

This parameter sets the direction for positive angle increment.

"Offset in degree" and "CW for positive" will be set during Auto-Phasing of the motor.

6 Programmable Features and Parameters

All SimpleServo drives are configured through the serial interface. The drives have many programmable and configurable features and parameters. These features and parameters are accessible via a universal software called MotionView. Please Refer to the MotionView User's Manual for details on how to make a connection to the drive and change parameter values.

This chapter covers programmable features and parameters specific to SimpleServo drives in the order they appear in the left tree of the MotionView. Programmable parameters are divided into groups. Each group holds one or more user's adjustable parameters.

6.1 Parameters storage and EPM operation

6.1.1 Parameter's storage

All settable parameters are stored in the drive's internal non-volatile memory. Parameters are saved automatically when they are changed. In addition, parameters copied to the EPM memory module located on the drive's front panel. In the unlikely event of drive failure, the EPM can be removed and inserted into the replacement drive, thus making an exact copy of the drive being replaced. This shortens down time by eliminating the configuration procedure. The EPM can also be used for replication of the drive's settings.

6.1.2 EPM operation

When the drive is powered up it first checks for a blue EPM in the EPM Port. If the EPM Port is empty or has a different color EPM inserted, no further operation is possible until a blue EPM is installed into the EPM Port. The drive will display "EP P" until a blue EPM is inserted.

If a blue EPM is detected, the drive compares data in the EPM to that in its internal memory. In order for the drive to operate, the contents of the drive's memory and EPM must be the same. If the contents are different then two behaviors are possible:

Case 1: EPM data is valid but different from the drive's memory.
Drive display allow one of the two copy operations: "E-d" (EPM to drive) or "d-E" (drive to EPM). You can choose the operation by pressing the arrow ▼ button. Pressing the "Enter" ↵ button executes the copy making the drive ready to operate.

Case 2: EPM is not formatted with drives format.
In this case there is only "d-E" (drive to EPM) copy operation possible. Pressing the "Enter" ↵ button copies drive's memory contents to EPM making the drive ready to operate.

> **Note**
>
> If the EPM contains any data from an inverter drive, data will be overwritten during this procedure.

6.1.3 EPM fault

If the EPM fails during operation or the EPM is removed from the EPM Port the drive will generate a fault and will disable (if enabled). The fault is logged to the memory. Further operation is not possible until the EPM is replaced (inserted) and the drive's power is cycled. The fault log on the display shows "F_EP" fault.

6.2 Motor Group

The motor group shows the data for the currently selected motor. Refer to Section 5.5 for details on how to select another motor from the motor database or to configure a custom motor.

6.3 Parameters Group

6.3.1 Drive operating modes

The SimpleServo has 6 operating mode selections: Torque, Velocity, Position, Velocity limited torque, CAN Torque and CAN Velocity (the latter two selections are described in the CAN documentation found in the MotionView help (Product Manuals).

For Torque and Velocity modes the drive will accept an analog input voltage on the AIN+ and AIN- pins of P3 (see section 5.3.1). This voltage is used to provide a torque or speed reference.

For Position mode the drive will accept step and direction logic signals or a quadrature pulse train on pins P3.11-14.

6.3.1.1 Torque mode

In torque mode, the SimpleServo control provides a current output proportional to the analog input signal, up to the maximum output current rating of the drive. Set Current (current the drive will try to provide) is calculated using formula:

Set Current(A) = Vinput(Volt) x Iscale (A/Volt)

where:
- Vinput is voltage at analog input (AIN+ and AIN-)
- Iscale is current scale factor (input sensitivity) set by the Analog input (Current Scale) parameter (section 6.3.5).

6.3.1.2 Velocity mode

In velocity mode, the servo controller regulates motor shaft speed (velocity) proportional to analog input voltage.
Target speed (set speed) is calculated using formula:

Set Velocity (RPM) = Vinput (Volt) x Vscale (RPM/Volt)

where:
- Vinput is voltage at analog input (AIN+ and AIN-)
- Vscale is velocity scale factor (input sensitivity) set by the Analog input (Velocity scale) parameter (section 6.3.6).

6.3.1.3 Position mode

In this mode the drive reference is a pulse-train applied to P3.11-14 terminals. Input can be configured for two types of signals: step and direction and Master encoder quadrature signal. Refer to section 5.2.1 for details on these inputs connections. Refer to section 8.3 for details about positioning and gearing.

6.3.1.4 Velocity limited torque mode

This mode is identical to “Torque Mode” (described in 6.3.1.2) except that speed will be restricted to the value set in the “Velocity limit” parameter (section 6.3.20). Upon reaching the velocity limit, the drive will maintain speed rather than torque: The “Velocity P-gain” and “Velocity I-gain” parameters (section 6.9) must be correctly set in order to maintain normal operation and stability when speeds are close to the “Velocity limit”. Velocity I-gain must be greater than 10 for this mode to operate correctly.

6.3.2 Drive PWM frequency

This Parameter sets the PWM carrier frequency. Frequency can be changed only when drive is disabled. Maximum overload current is 300% of drive rated current when the carrier is set to 8KHZ, it is limited to 250% at 16KHZ.

6.3.3 Current Limit

The CURRENT LIMIT setting determines the nominal current, in amps RMS per phase.

6.3.4 8 KHZ Peak current limit and 16 KHZ Peak current limit

Peak current sets Motor RMS phase current that is allowed for up to 2 Seconds. After this two second limit, the current limit will be reduced to the value set in the Current Limit parameter. When the motor current drops below nominal current for two seconds, the drive will automatically re-enable the peak current level. This technique allows for high peak torque on demanding fast moves and fast start/stop operations with high regulation bandwidth. The control will use only the Peak current limit parameter for the carrier frequency selected.

6.3.5 Analog input scale (Current scale)

This parameter sets analog input sensitivity for current reference used when drive operates in Torque mode. Units for this parameter are A/Volt. To calculate this value use the following formula:

Iscale = Imax / Vin max

Imax maximum desired output current (motor phase current RMS)
Vin max max voltage fed to analog input at Imax

Example: Imax = 5A (phase RMS)
Vin max = 10V
Iscale = Imax / Vin max = 5A / 10V = 0.5 A / Volt -> value to enter.

6.3.6 Analog input scale (Velocity scale)

This parameter sets analog input sensitivity for velocity reference used when the drive operates in Velocity mode. Units for this parameter are RPM/Volt. To calculate this value use the following formula:

Vscale = VELOCITYmax / Vin max

VELOCITYmax maximum desired velocity in RPM
Vin max max voltage fed to analog input at Velocitymax
Example: VELOCITYmax = 2000 RPM
Vin max = 10V
Vscale = VELOCITYmax / Vin max
= 2000 / 10V
= 200 RPM / Volt (**value to enter**)

6.3.7 ACCEL/DECEL Limits (Velocity mode only)

The ACCEL setting determines the time the motor takes to ramp to a higher speed. The DECEL setting determines the time the motor takes to ramp to a lower speed. If the ENABLE ACCEL\DECEL LIMITS is set to DISABLE, the drive will automatically accelerate and decelerate at maximum acceleration limited only by current limit established by the PEAK CURRENT LIMIT and CURRENT LIMIT settings.

6.3.8 Reference (Velocity mode only)

The REFERENCE setting selects the reference signal being used.
Select Internal only when you using drive's built-in digital signal generator MotionView's Run Panel (section 6.10.2.2) for tuning purposes. Select External for normal operation.

6.3.9 Step input type (position mode only)

This parameter sets the type of input for position reference the drive expects to see. Signal type can be step and direction (S/D) type or quadrature pulse-train (Master Encoder / Electronic Gearing). Refer to section 5.2.1 for details on these inputs.

6.3.10 Reset Option

RESET OPTION selects the type of action required to reset the drive after a FAULT signal has been generated by the drive. ON DISABLE clears the fault when the drive is disabled. This is useful if you have a single drive and motor connected in a simple servo system. The ON ENABLE option clears the fault when the drive is re-enabled. Choose ON ENABLE if you have a complex servo system with multiple drives connected to an external controller. This makes troubleshooting easier since the fault will not be reset until the drive is re-enabled. Thus, a technician can more easily determine which component of a complex servo system has caused the fault.

6.3.11 Motor temperature sensor

This parameter enables/disables motor over-temperature detection. It must be disabled if the motor PTC sensor is not wired to either P7.1-2 or to the resolver option module (P11).

6.3.12 Motor PTC cut-off resistance

This parameter sets resistance of PTC at which motor reaches maximum allowable temperature. See section 5.5.2 for details how to connect motor's PTC.

6.3.13 Second encoder

Disables or enables second encoder. Effectively selects single-loop or double-loop configuration in position mode. The second encoder connects to the Encoder Option Module (E94ZAENC1) connector P12, Refer to section 8.4 for details on dual loop operation.

6.3.14 Regen duty cycle

This parameter sets maximum duty cycle for the brake (regen) resistor. This parameter can be used to prevent brake resistor overload. Use following formula to set correct value for this parameter.

$$D = P * R / (Umax)^2 * 100\%$$

where:

D (%)	regen duty cycle
Umax (V)	bus voltage at regen conditions. Umax=390V for 230VAC drives and 770V for 400/480VAC drives
R (ohm)	regen resistor value
P (W)	regen resistor rated power

Note
If calculation of D is greater than 100% set it to 100% value. If calculation of D is less than 10% then resistor power rating is too low. Refer to section 5.1.6 for details on braking resistor selection.

6.3.15 Encoder repeat source

This parameter sets the feedback source signal for the buffered encoder repeat outputs (P3.1-6). The source can be the drive's encoder input (P4) or an optional feedback module (resolver, second encoder etc.)

6.3.16 Master to system ratio

This parameter used to set scale between the reference pulse train (when operating in position mode) and the system feedback device. In a single loop configuration, the system feedback device is the motor encoder or resolver. In a dual-loop system the system encoder is the second encoder. See sections 8.3 and 8.4 for details.

6.3.17 Second to prime encoder ratio

This parameter sets ratio between secondary encoder and primary feedback device when the drive is configured to operate in dual-loop mode. When the primary feedback device is a resolver, the pulse count is fixed at 65, 536. The resolutions of encoders are "post quadrature" (PPR x 4). See section 8.4

Note

Post quadrature pulse count is four times the pulses-per-revolution (PPR) of the encoder.

6.3.18 Software drive enable

Provides a dialog box that allows the drive to be enabled through MotionView, in conjunction with the ENABLE input on the drive.

This parameter does not enable the drive, but rather only allows the use of the "enable" button in MotionView's Tools - Run Panels folder (see section 6.10.2.4). Unlike other parameters, this parameter always initializes to disable when the drive is powered up, regardless of how it was left in the previous session.

6.3.19 Velocity limit

This parameter sets the maximum speed that the motor will be allowed to reach when in "velocity limited torque" mode.

6.4 Communication

6.4.1 RS-485 configuration

This parameter sets how the optional RS485 interface will function. The RS485 interface can be configured for normal operation (programming and diagnostics using MotionView software) or as a Modbus RTU slave. See section 5.4 for details on communication interfaces.

6.4.2 Modbus baud rate

This parameter sets baud rate for RS485 interface in Modbus RTU mode. When drive is operating in normal mode baud rate is set to the same as for RS232 interface.

6.4.3 Modbus reply delay

This parameter sets time delay between drive reply to Modbus RTU master. This delay is needed for some types of Modbus masters to function correctly.

6.5 Analog I/O Group

6.5.1 Analog output

SimpleServo has one analog output with 10-bit resolution on P3.21. The signal is scaled to ± 10V. The analog output can be assigned to following functions:

- Not Assigned
- Phase current RMS
- Phase current Peak
- Motor Velocity
- Phase R current
- Phase S current
- Phase T current
- Iq current (Torque component)
- Id current (Direct component)

6.5.2 Analog output current scale (Volt/amps)

Applies scaling to all functions representing CURRENT values.

6.5.3 Analog output velocity scale (mV/RPM)

Applies scaling to all functions representing VELOCITY values.
(Note: that mV/RPM scaling units are numerically equivalent to volts/kRPM)

6.5.4 Analog input dead band

Allows the setting of a voltage window (in mV) at the reference input AIN+ and AIN- (P3.23 and 24) such that any voltage within that window will be treated as zero volts. This is useful if the analog input voltage drifts resulting in motor rotation when commanded to zero.

6.5.5 Analog input offset parameter

Allows you to adjust the offset voltage at AIN+ and AIN- (P3.23 and P3.24). This functions as the equivalent to the balance trim potentiometer found in analog drives. Lenze recommends that this adjustment be made automatically using the "Adjust analog voltage offset" button while the external analog reference signal commands zero speed.

6.5.6 Adjust analog voltage offset

This control button is useful to allow the drive to automatically adjust analog input voltage offset. To use it, command the external reference source input at AIN+ and AIN- (P3.23 and 24) to zero volts and then click this button. Any offset voltage at the analog input will be adjusted out and the adjustment value will be stored in the "Analog input offset" parameter.

6.6 Digital I/O

6.6.1 Digital input function

Digital input IN2 (P3.10) is programmable as follows:

- **Not assigned** Input not assigned and has no effect on drive operation.
- **External fault** Input serves as external fault input. Servo will stop and indicate fault if this input is activated.
- **Stop (Rapid)** In velocity or current mode sets input reference to 0 regardless of voltage on analog input.
- **Reference Reverse** Sign of input reference voltage is reversed.

6.6.2 Digital output 1 and 2 function

Digital outputs OUT1 (P3.15 and 16) and OUT2 (P3.19 and 20) can be individually assigned to the following functions.

- **Not assigned** No function has been assigned for the digital output
- **Zero Speed** Motor is at or below the zero speed threshold set by the "zero speed" parameter in the Velocity Limits Group
- **In Speed Window** Motor shaft RPM is within the speed range as defined in the "At speed" and "Speed Window" parameters in the Velocity Limits Group (section 6.7).
- **Current Limit** Drive current output has exceeded the limit set in the "Current Limit" parameter in the Drive Parameters Group.
- **Run Time Fault** A fault has occurred. Refer to Section 7.3 for details on faults.
- **Ready** Drive is enabled.
- **Brake** Command for the holding brake option (E94ZAFFD1) for control of a motor mounted brake. This output is active 10ms after the drive is enabled and deactivates 10ms before the drive is diabled.

6.6.3 Digital input polarity

Parameter sets logic polarity for digital input: active low or active high.

> **Note**
>
> The "active high" state asserts the defined function when current is flowing through the input circuit. The "active low" state de asserts the defined function when current is flowing through the input circuit.

6.6.4 Digital output 1 and 2 polarity

Parameter sets polarity, Normally Closed or Normally Open, of the digital outputs.

> **Note**
>
> The "normal" condition is the state of an output is when the condition for its defined action has not been met.
>
> Example: Output is to be on until the a fault has occurred.
> Program OUT1 for "Run time fault" and polarity for Normally Closed.

6.6.5 Digital input de-bounce time

Sets de-bounce time for the digital input IN2 (P3.10) to compensate for bouncing of switch or relay contacts. This is the time during an input transition that the signal must be stable before it is recognized by the drive.

6.6.6 Enable input de-bounce time

Sets de-bounce time for the ENABLE input, digital input IN1 (P3.17), to compensate for bouncing of switch or relay contacts.

6.7 Velocity Limits Group

These parameters are active in Velocity Mode Only.

6.7.1 ZERO SPEED

Specifies the upper threshold for motor zero speed in RPM. When motor shaft speed is at or below the specified value the zero speed condition is set to true in the internal controller logic. The zero speed condition can also trigger a programmable digital output, if selected (see section 6.6.2).

6.7.2 SPEED WINDOW

Specifies the speed window width used with the “In speed window” output (section 6.6.2).

6.7.3 AT SPEED

Specifies the speed window center used with the “In speed window” output (section 6.6.2).

These last two parameters specify speed limits. If motor the shaft speed is within these limits then the condition AT SPEED is set to TRUE in the internal controller logic. The AT SPEED condition can also trigger a programmable digital output, if selected.

For example if “AT SPEED” is set for 1000 RPM, and the “SPEED WINDOW” is set for 100, then “AT SPEED” will be true when the motor velocity is between 950 -1050 RPM.

6.8 Position limits

6.8.1 POSITION ERROR

Specifies the maximum allowable position error in the primary (motor mounted) feedback device before enabling the “Max error time” clock (described next). When using an encoder, the position error is in post-quadrature encoder counts. When using a resolver, position error is measured at a fixed resolution of 65,536 counts per motor revolution.

6.8.2 MAX ERROR TIME

Specifies maximum allowable time (in mS) during which a position error can exceed the value set for the “Position error” parameter before a Position Error Excess fault is generated.

6.8.3 SECOND ENCODER POSITION ERROR

Specifies the maximum allowable error of the second encoder in post quadrature encoder counts before enabling the “Second encoder max error time” clock (described next).

6.8.4 SECOND ENCODER MAX ERROR TIME

Specifies maximum allowable time (in mS) during which the second encoder’s position error can exceed the value set for the “Second encoder position error” parameter before a Position Error Excess fault is generated.

6.9 Compensation group

6.9.1 Velocity P-gain (Proportional)

Proportional gain adjusts the system's overall response to a velocity error. The velocity error is the difference between the commanded velocity of a motor shaft and the actual shaft velocity as measured by the primary feedback device. By adjusting the proportional gain, the bandwidth of the drive is more closely matched to the bandwidth of the control signal, ensuring more precise response of the servo loop to the input signal.

6.9.2 Velocity I-gain (Integral)

The output of the velocity integral gain compensator is proportional to the accumulative error over cycle time, with I-gain controlling how fast the error accumulates. Integral gain also increases overall loop gain at the lower frequencies, minimizing total error. Thus, its greatest effect is on a system running at low speed, or in a steady state without rapid or frequent changes in velocity.

Note

The following four position gain settings are only active if the drive is operating in Position mode. They have no effect in Velocity or Torque modes.

6.9.3 Position P-gain (Proportional)

Position P-gain adjusts the system's overall response to position error. Position error is the difference between the commanded position of the motor shaft and the actual shaft position. By adjusting the proportional gain, the bandwidth of the drive is more closely matched to the bandwidth of the control signal, ensuring more precise response of the servo loop to the input signal.

6.9.4 Position I-gain (Integral)

The output of the Position I-gain compensator is proportional to accumulative error over cycle time, with I-gain controlling how fast the error accumulates. Integral gain also increases overall loop gain at the lower frequencies, minimizing total error. Thus, its greatest effect is on a system running at low speed, or in a steady state without rapid or frequent changes in position.

6.9.5 Position D-gain (Differential)

The output of the Position D-gain compensator is proportional to difference between current position error and the position error measured in the previous servo cycle. D-gain decreases bandwidth and increases overall system stability. It is responsible for removing oscillations caused by load inertia and acts similar to a shock-absorber in a car.

6.9.6 Position I-limit

The Position I-limit will clamp the Position I-gain compensator to prevent excessive torque overshooting caused by an over accumulation of the I-gain. It is defined in terms of percent of maximum drive velocity. This is especially helpful when position error is integrated over a long period of time.

6.9.7 Second encoder I-gain (Integral)

This parameter sets second encoder position I-gain when the drive is in a dual-loop configuration.

6.9.8 Velocity regulation window

Sets total velocity loop gain multiplier (2^n) where n is the velocity regulation window. If, during motor tuning, the velocity gains become too small or too large, use this parameter to adjust loop sensitivity. If the velocity gains are too small, decrease the total loop gain value by deceasing this value. If gains are at their maximum setting and you need to increase them even more, use a larger value for this parameter.

6.9.9 Tune gains button

This command button opens a window with all gains configured as sliders for more convenient set-up.

6.10 Tools Group

6.10.1 Oscilloscope tool

Oscilloscope tool gives real time representation of different signals inside the SimpleServo drive and is helpful when debugging and tuning drives. Operation of oscilloscope tool is described in more detail in the MotionView Software User's Manual. Following are the signals that can be observed with the oscilloscope tool:

Phase Current (RMS):	Motor phase current
Phase Current (Peak):	Motor peak current
Iq Current:	Measures the motor Iq (torque producing) current
Motor Velocity:	Actual motor speed in RPM
Commanded Velocity:	Desired motor speed in RPM (velocity mode only)
Velocity Error:	Difference in RPM between actual and commanded motor speed
Position Error:	Difference between actual and commanded position (Step & Direction mode only)
Bus voltage:	DC bus voltage
Analog input:	Voltage at drive's analog input

6.10.2 Run Panels

6.10.2.1 Drive and motor monitor

This button activates a separate window that displays the status of the motor mounted encoder (position and halls status) or resolver (position). The second encoder and master encoder positions, if connected, are also shown. This window also allows viewing of the commanded position of the motor and allows comparison with the actual position.

6.10.2.2 Run Panel

Run Panel is active in velocity mode only. It replicates an analog “slider” style potentiometer as if it were connected to the analog reference input. The “Analog input velocity scale” parameter (section 6.3.6) set the scale for this “potentiometer” the same way it sets it for the analog input. The “Enable reference sweep” check box allows the user to generate a bipolar square-wave reference who’s period is set by the “sweep time” and max speed set by the “potentiometer”. This bipolar square wave allows the motor to continually cycle between forward and reverse for easy velocity mode tuning.

6.10.2.3 Check Phasing

This button activates the Autophasing feature as described in section 5.6.2. However, in this panel only the motor phasing is checked, the motor data is not modified.

6.10.2.4 Enable and Disable buttons

These buttons will enable and disable the servo controller in a similar manner as the ENABLE input on P3.17. For the “Enable button” to function, the “Software drive enable” parameter (see section 6.3.19) must be set to “enable”. The “Disable” button will work regardless of this parameter setting, as long as communications with the drive are functioning.

WARNING!
Starting of the drive from the MotionView software enable will override the hardware ENABLE (P3.17) when in the disable state. The operator must ensure that motor and machine are safe to operate prior to enabling the drive.

Failure to comply could result in damage to equipment and/or injury to personnel!

6.10.3 Drive info

The “Firmware build” button shows the drive firmware version.

6.11 Faults Group

Faults Group loads fault history from the drive. The 8 most recent faults are displayed with newer faults replacing older faults in a first-in, first-out manner. In all cases fault # 0 is the most recent fault. To clear faults history from the drive’s memory click on “Reset Fault history” button. Each fault has its code and explanation of the fault. See section 7.3 for details on faults.

7 Display and Diagnostics

7.1 Diagnostic display

SimpleServo drives are equipped with a diagnostic LED display and 3 push buttons to select displayed information and to edit a limited set of parameter values.

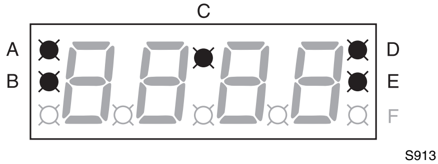
Parameters can be scrolled by using “UP” and “DOWN” (▲▼) buttons. To view a value, press “Enter”(↵). To return back to scroll mode press “Enter” again.

After pressing the ”Enter” button on editable parameters, the yellow LED “C” (see figure in the next section) will blink indicating that parameter value can be changed. Use “UP” and “DOWN” buttons to change the value. Press “Enter” to store new setting and return back to scroll mode.

Display	Description
StAt	current drive status - ↵ to view: rUn - drive running d iS - drive disabled F_XX - drive fault. Where XX is the fault code (section 7.3.2)
Hx.xx	Hardware revision (ex. H1.01)
Fx.xx	Firmware revision (ex. F1.10)
OPEr	Operating mode - ↵ to set: POS - position mode UEL - velocity mode torq - torque mode CAnU - CANBUS velocity mode CAnt - CANBUS torque mode t-UL - velocity limited torque mode
bAUd	RS232/RS485(normal mode) baud rate - ↵ to set ▲▼ selects 38.4, 19.2, 9.6 (kbps) baudrate
Adr	Drive’s address - ↵ to set ▲▼ sets 0 - 31 drive’s address
FLtS	Stored fault’s history - ↵ to view ▲▼ scroll through stored faults F0XX to F7XX, where XX is the fault code (section 7.3.2)
Ht	Heatsink temperature - ↵ to view Shows heatsink temperature in °C if greater than 40°C. Otherwise shows “LO” (low).
EnC	Encoder activity - ↵ to view Shows primary encoder counts for encoder diagnostics activity
HALL	Displays motor’s hall sensor states - ↵ to view Shows motor hall states in form XXX , where X is 1 or 0 - sensor logic states.
bUS	Displays drive DC bus voltage - ↵ to view Shows DC bus voltage value
CUrr	Displays motor’s phase current (RMS) Shows current value if drive is enabled, otherwise shows “d iS”

7.2 Diagnostic LED's

The SimpleServo has five diagnostic LEDs mounted on the periphery of the front panel display as shown in the drawing below. These LEDs are designed to help monitor system status and activity as well as troubleshoot any faults.



LED	Function	Description
A	Enable	Orange LED indicates that the drive is ENABLED (running).
B	Regen	Yellow LED indicates the drive is in regeneration mode.
C	Data Entry	Yellow LED will flash when changing.
D	Comm Fault	Red LED illuminates upon a communication fault.
E	Comm Activity	Green LED flashes to indicate communication activity.

7.3 Faults

7.3.1 FAULT CODES

Fault Code	Fault	Description
F_0U	Over voltage	Drive bus voltage reached maximum level, typically due to motor regeneration
F_Fb	Feedback error	Resolver signal lost or at least one motor hall sensor is inoperable or not connected.
F_0C	Over current	Drive exceeded peak current limit.
F_0t	Over temperature	Drive heatsink temperature has been reached maximum rating.
F_EF	External fault input activated	Digital input was programmed as external fault input and has been activated.
F_0S	Over speed	Motor reached velocity above its specified limit
F_PE	Excess position error	Position error exceeded maximum value.
F_bd	Bad motor data	Motor profile data invalid or no motor is selected
F_09	Motor over temperature	Optional motor temperature sensor (PTC) indicates that the motor windings have reached maximum temperature
F_ 14	Low Bus Voltage	DC Bus voltage has fallen below operating tolerance.
F_**xx**	Restricted	Contact Lenze service for any Fault Code not identified above.

7.3.2 Fault Event

When drive encounters any fault, the following events occur:

- Drive is disabled
- Internal status is set to "Fault"
- Fault number is logged in the drive's internal memory for later interrogation
- Digital output(s), if configured for "Run Time Fault", are asserted
- Digital output(s), if configured for READY, are de asserted
- If the display is in the default status mode, the LED's display F_XX where XX is current fault code.
- "Enable" LED turns OFF

7.3.3 Fault Reset

Fault reset is accomplished by disabling or re-enabling the drive depending on the setting of the "Reset option" parameter (section 6.3.10).

8 Operation

8.1 Minimum Connections

For the most basic operation, connect the SimpleServo 94 to mains (line) power at terminal P1, the servomotor power at P7 and the motor feedback as appropriate.

DANGER!
Hazard of electrical shock! Circuit potentials are up to 480 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing drive. Capacitors retain charge after power is removed.

Below is a list of the minimum necessary connections:

- Connect serial cable between SimpleServo's P2 and your PC serial port using a straight-through 9 pin RS232 cable (available as EWLC003BA1NA).
- Connect mains power to terminal P1. Mains power must be as defined on the drive's data label (see section 2.1).
- If motor is equipped with an encoder, connect the encoder cable to SimpleServo feedback connector P4.
  If motor is equipped with a resolver, install the "Resolver option module" (E94ZARSV1) in the lower option bay and connect resolver cable to P11.
- Connect motor windings U, V, W (sometimes called R, S, T) to terminal P7 according to Section 5.1.1. Make sure that motor cable shield is connected as described in section 4.2.
- Provide an Enable switch according to Section 8.5.
- Perform drive configuration as described in the next section.

Note

You must configure the drive before it can operate.
Proceed to Section 8.2.

8.2 Configuration of the SimpleServo

Regardless of the mode in which you wish to operate, you must first configure the SimpleServo for your particular motor, mode of operation, and additional features if used.

Drive configuration consists of following steps:

- Motor Selection
- Mode of operation selection
- Drive parameters (i.e. current limit, acceleration / deceleration) setup
- Operational limits (velocity or position limits) setup
- Input / Output (I/O) setup
- Velocity / position compensator (gains) setup
- Optionally store drive settings in a PC file and exit the MotionView program.

To configure drive:

1. Ensure that the control is properly installed and mounted. Refer to Section 4 for installation instructions.
2. Perform wiring to the motor and external equipment suitable for desired operating mode and your system requirements.
3. Connect drive serial port P2 to your PC serial port.
4. Make sure that the drive is disabled.
5. Apply power to the drive and wait until “d iS” shows on the display. For anything other then this, refer to the chart below before proceeding.

Drive display:	Meaning
EP ?	EPM missing. Refer to 6.1.2
d-E	EPM data Refer to 6.1.2
E-d	EPM data Refer to 6.1.2
- - - -	No valid firmware
- - - -	Monitor mode

6. Using drive’s keypad and display, check that baud rate is set to 38.4 (kbps).
7. Using drive’s keypad and display, check that address is 1. Set if necessary.
8. Launch MotionView software on your computer.
9. From the MotionView menu, select <Project> <Connection setup>.
10. Select “UPPP over RS-485/RS-232”, then select <Properties> and select computer’s serial port drive connected to.
    - Select the Comm port that matches the serial port of the computer used for this connection
    - Set baud rate at 38400 and rest of the parameters at default.
11. Click <OK> twice to dismiss both dialog boxes.
12. From <Node> menu choose <Connect Drive>.
13. Click “Connect one” button, type “1” in the address box and press “OK” to dismiss dialog.
14. Drive connects and its icon appears in the left node tree of the MotionView’s screen.

Note

MotionView’s “Connection setup” properties need only be configured the first time MotionView is operated or if the port connection is changed. Refer to MotionView User’s Manual for details how to make a connection to the drive.

15. Double-click on the drive’s icon to expand parameter group’s folders.
16. Select the motor to be used according to the Section 5.5.
17. Expand the folder “Parameters” and choose the operating mode for the drive. Refer for details to Section 6.3.1 for details on operating modes.
18. Click on the “Current limit” parameter (6.3.3) and enter current limit (in Amp RMS per phase) appropriate for the motor.
19. Click on the appropriate “Peak current limit” parameter (6.3.4) based on the “Drive PWM frequency” parameter (6.3.2) used and enter the peak current limit (in Amp RMS per phase) appropriate for your motor.
20. Set up additional parameters suitable for operating mode selected in step 17.
21. After you configure the drive, proceed to the tuning procedure if operating in Velocity, Position, or Velocity limited torque mode. Torque mode doesn’t require additional tuning or calibration. Refer to Section 8.6 for details on tuning.

8.3 Position mode operation (gearing)

In position mode the drive will follow master reference signals at the P3.11-14 inputs. The distance the motor shaft rotates per each master pulse is established by the ratio of the master signal pulses to motor encoder pulses (in single loop configuration). The ratio is set by “Master to System ratio” parameter (see section 6.3.17).

Example 1.

Problem: Setup drive to follow a master encoder output where 1 revolution of the master encoder results in 1 revolutions of the motor

Given: Master encoder 4000 pulses / revolution (post quadrature)
Motor encoder: 8000 pulses / revolution (post quadrature)

Solution: Ratio of Master Encoder to System (motor encoder) is 4000/8000 = 1/2
Set parameter “Master to system ratio” to 1:2

Example 2

Problem: Setup drive so motor can follow a master encoder wheel where 1 revolution of the master encoder results in 3 revolutions of the motor

Given: Master encoder wheel is 1000 pulses / revolution (post quadrature).
Motor encoder 4000 pulses / revolution (post quadrature)
Desired “gear ratio” is 1:3

Solution: Ratio is master encoder PPR divided by motor encoder PPR times the “gear ratio”:
(Master PPR / Motor PPR)*(1/3) => (1000/4000)*(1/3) => 1/12
Set parameter “Mater to system ratio” to 1:12

8.4 Dual-loop feedback

In dual-loop operation (position mode only) the relationship between Master input and mechanical system movement requires that two parameters be set:

(1) “Master to system ratio” sets the ratio between master input pulses and the second encoder pulses (system encoder).

(2) “Second to prime encoder ratio” sets the ratio between the second and primary (motor) encoder. If the motor is equipped with a resolver connected to the resolver option module (E94ZARSV1), the primary encoder resolution of 65536 (post quadrature) must be used.

8.5 Enabling the SimpleServo

Regardless of selected operating mode, the SimpleServo must be enabled before it can operate. A voltage in the range of 5-24 VDC connected between P3-17 and 18 is used to enable the drive. Impedance of this input is approximately 700 ohms.

WARNING!
Enabling the servo drive allows the motor to operate depending on the reference command. The operator must ensure that motor and machine are safe to operate prior to enabling the drive and that moving elements are appropriately guarded.

Failure to comply could result in damage to equipment and/or injury to personnel!

8.6 Tuning in velocity mode

> **Note**
>
> In this mode, the settings for Position compensation have no effect.

1. Make sure that power is applied to the drive and that the drive is connected to a PC running MotionView software
2. Make sure that the drive is disabled and dıS is displayed on the drive.
3. Select the “Parameters” folder from the node tree. Click on “Reference” parameter and change it to “Internal”. This will tell drive to use internally generated reference controlled by Run panel tool.
4. Make sure that “Enable Accel/Decel limits” is set to “Disable”.
5. Select “Tools” then “Run Panels” then “Run Panel” from the node tree to bring up the run panel control window.
6. Select “Oscilloscope” tool from node tree to engage oscilloscope. Check checkbox “Always on top”, so MotionView main window doesn’t cover oscilloscope tool.
7. On the Scope tool select:
    - Phase current (RMS) as source for Channel 1
    - Motor Velocity as source for Channel 2
    - Timebase: 50ms/div
    - Trigger: Channel 2, Rising
    - Trigger level 0 Rpm
8. Enable the drive.
9. Set the Reference slider in the Run panel to a motor test speed. If the motor’s maximum speed is less than 5000 RPM, set the slider to approximately 250 RPM. If the motor’s maximum speed is greater than 5000 RPM, set the slider to approximately 500 RPM. After setting the slider to the appropriate test speed, the motor should begin to run.
10. Set reference sweep to 200 mS. The sweep range is 10 - 1000 milliseconds (msec). Check the “Enable Reference Sweep” box. By enabling reference sweep, a bi-polar square-wave signal is generated, which allows monitoring of the motor’s behavior when changing direction.
11. Select “Compensation” from node tree. Set “Velocity regulation window” to “-6” for encoder feedback motors or to “-8” for resolver feedback motors. Set “Velocity P-gain” to 2000 and “Velocity I-gain” to 100.
12. Slowly increase the “Velocity P-gain” until the current waveform grows to a maximum value when velocity changes from negative to positive (or visa versa). See sample waveforms in Section 9.1.
13. Slowly increase “Velocity I-gain” and watch for overshoot on motor velocity waveform. Leave it at a level where overshoot just starts to happening or is very narrow (less then 5mS or less then 3-5%). If fast acceleration/deceleration in your servo system is not an objective, but stiffness at low velocity or stall torque is, “Velocity I-gain” can be increased allowing overshoot up to approximately 15-20%.
14. Finally, check the motor Iq current. Set oscilloscope Channel 1 source to Iq current. Observe current waveform and insuring that there is no significant oscillation.
15. On the Run panel, click the “Set to Zero” button to stop the motor. Disable the drive.
16. Optionally select “Parameters” from node tree then set “Reference” parameter to “External” so next time that the drive is enabled, it will use analog input for reference.

8.7 Tuning in position mode

Note

In this mode the Velocity gains should be set first.

1. Perform velocity loop tuning as per section 8.6.
2. Make sure that the drive is disabled and dis is displayed on the drive.
3. Set up the external indexer to perform the following move:
   - Move forward N steps, where N = number of steps to perform one full motor shaft revolution.
   - Move backward N steps, where N = number of steps to perform one full motor shaft revolution.
4. Set “Accel limit” and “Decel limit” to the maximum the application requires or that the system allows.
5. Select “Tools” then “Oscilloscope” tool from node tree.
6. On the “Oscilloscope” tool select:
   - Motor Velocity as source for Channel 1
   - Position error as source for Channel 2.
   - Timebase: 50ms/div
   - Trigger: Channel 1, Rising.
7. Set the “Drive mode” to “Position” and “Step input type” as appropriate. Ensure “Master to system ratio” is properly set as described in section 6.3.17 and section 8.3.
8. Select “Compensation” from node tree. Set “Position P-gain” to 100 and “Position D-gain” to 200. Set “Position I-gain” to 0 and “Position I-limit” to 0.
9. Enable the drive.
10. Run indexer and observe position error waveform.
11. Slowly increase simultaneously P-gain and D-gain and watch for Position error waveform. Continue to increase both gains until noticeable oscillation on flat portion of waveform is observed. At this point stop increasing P-gain, and continue to increase D-gain until oscillation stops. The ratio between P-gain and D-gain is now set and if P-gain needs adjustment in the next steps the D-gain will need to be adjusted accordingly to maintain the ratio. The goal is to minimize position error by increasing P-gain, and at the same time avoid oscillation and instability by increasing D-gain. There could be a case when increasing P-gain breaks the system into oscillation and audible noise can be heard and increasing D-gain does not fix the situation. At this point lower P-gain (and possibly lower D-gain as well) to the level where noise and instabilities disappear.
12. Finally, set motor velocity to a steady speed of 200 RPM and adjust “Position I-gain” and “Position I-limit” to obtain desirable result in steady state.
13. Stop indexer and disable drive.

Note

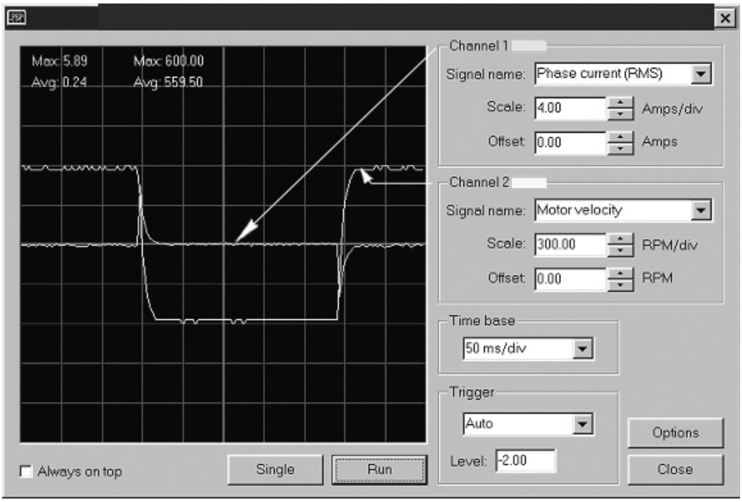
Remember that these are only initial settings for your system. Your application will likely require fine-tuning. To optimize settings you will need to experiment with combinations of all gains P, D and I and IL limit settings.

9 Sample Motor Responses to Gain Settings

9.1 Motor response to gain settings (Velocity mode)

9.1.1 Low P-gain

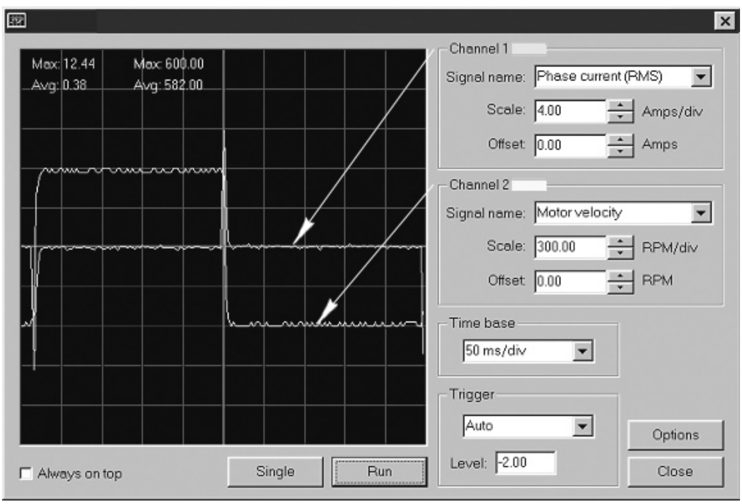
P-gain =100.
I-gain=0
Current didn't reach maximum possible value.



S914

9.1.2 Correct P-gain

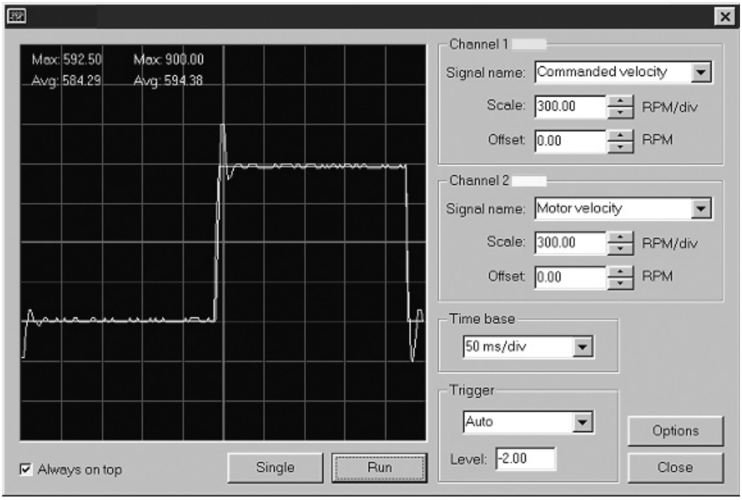
P-gain =500.
I-gain=0
Current reaches maximum value.



S915

9.1.3 I-gain too high

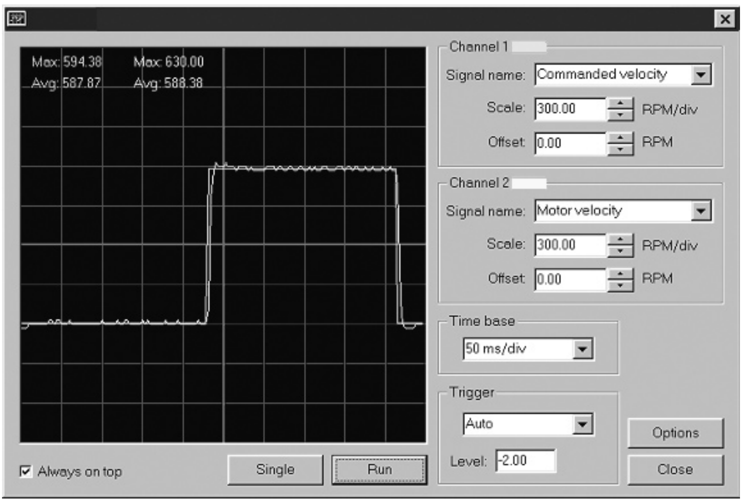
P-gain =500.
I-gain=300
Notice the high velocity overshoot.



S916

9.1.4 Correct P-gain and I-gain

P-gain =500.
I-gain=100
Notice a very low velocity overshoot and very close matching of the waveforms.



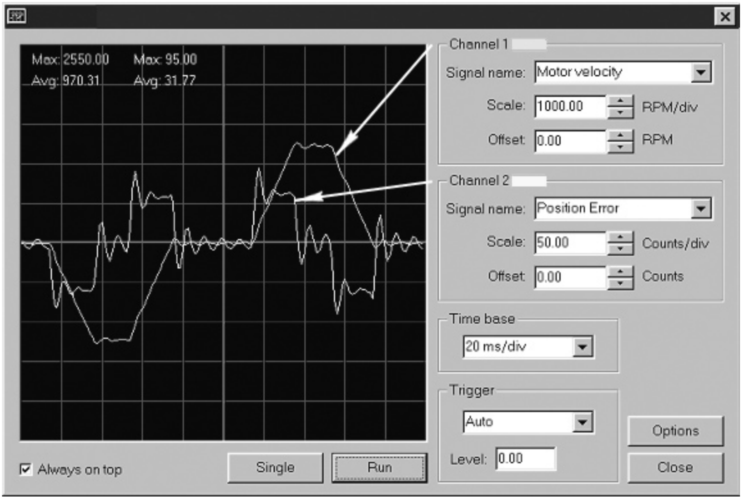
S917

9.2 Motor response to gain settings (Position Mode)

9.2.1 Non-optimal P-gain / D-gain relationship

P-gain = 200
D-gain = 300

Problem:	Noticeable oscillation (Channel 2). Insufficient D- gain / excess of P-gain for this D-gain setting.
Treatment:	Decrease P-gain, increase D - gain.
Side effects:	Decreasing P-gain increases position error, Increasing D-gain lowers bandwidth and increases hi frequency noise.

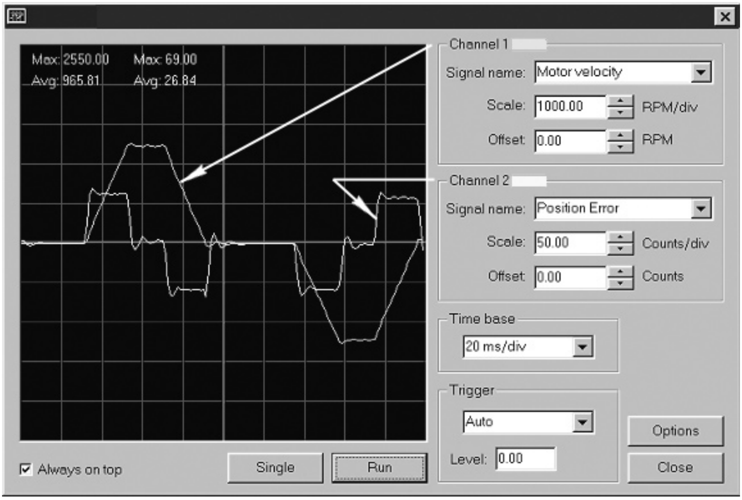


S918

9.2.2 Optimal P-gain / D-gain relationship

Note

Oscillation is eliminated. Position error is small and only 20 mS long. Position regulation bandwidth of the system is 1/20mS = 50Hz.



S919

10 Troubleshooting

DANGER!
Hazard of electrical shock! Circuit potentials are up to 480 VAC above earth ground. Avoid direct contact with the printed circuit board or with circuit elements to prevent the risk of serious injury or fatality. Disconnect incoming power and wait 60 seconds before servicing drive. Capacitors retain charge after power is removed.

Before troubleshooting

Perform the following steps before starting any procedure in this section:

- Disconnect AC or DC voltage input from the SimpleServo. Wait 60 seconds for power to discharge.
- Check the SimpleServo closely for damaged components.
- Check that no foreign material has become lodged on, or fallen into, the SimpleServo.
- Verify that every connection is correct and in good condition.
- Verify that there are no short circuits or grounded connections.
- Check that the drive's rated phase current and RMS voltage are consistent with the motor ratings.

For additional assistance, contact your local SimpleServo® authorized distributor.

Problem	External line fuse blows
Possible Cause	Line fuses are the wrong size Motor leads or incoming power leads are shorted to ground. *Nuisance tripping caused by EMI noise spikes caused by poor grounding and/or shielding.*
Suggested Solution	• Check that line fuses are properly sized for the motor being used. • Check motor cable and incoming power for shorts. • Check that you follow recommendation for shielding and grounding listed in section “shielding and grounding” early in this manual.

Problem	Ready LED is on but motor does not run.
Suggested Solution	**If in torque or velocity mode:** Reference voltage input signal is not applied. *Reference signal is not connected to the SimpleServo input properly; connections are open.* *In MotionView program check <Parameters> <Reference> set to <External>* **For Velocity mode only:** *In MotionView check <Parameters> <Compensation><Velocity loop filter> P-gain must be set to value more then 0 in order to run. Without load motor will run with P-gain set as low as 20 but under load might not. If P-gain is set to 0 motor will not run at all.* **In step and direction mode:** Step and Direction inputs are not wired correctly. *In MotionView program check <Parameters> <Step input type> is set for <S/D> if you use a step-and-direction indexer output; and <Master Encoder> if you use quadrature type output from a master motor encoder or indexer.* *Position loop P-gain set to 0. Set P-gain to 100 and D-gain to 200 If in PIVFF mode or if in P+V mode P-gain to 10 and D-gain for 5 and Velocity P-gain 50 and I-gain 20 initially to get motion. Tune them afterwards for best performance.*

Problem	In velocity mode, the motor runs away.
Possible Cause	• Hall sensors or encoder miswired. • SimpleServo not programmed for motor connected.
Suggested Solution	• Check Hall sensor and encoder connections. • Check that the proper motor is selected..

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