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HG103684 ISS2

PRODUCT MANUAL:

400XLV 800XLV 1200XLV

Contents

Sprint Electric Ltd accepts no liability whatsoever for the installation, fitness for purpose or application of its products. It is the user's responsibility to ensure the unit is correctly used and installed.

1 Description

The XLV range of dc servo motor controllers are designed for use with permanent magnet brushed dc servo motors rated from 4 to 12 amps.

The controllers can be used in either current (torque) or speed control modes. For highly dynamic applications, a shaft-mounted dc tacho-generator is recommended for speed feedback, however in less demanding applications, armature voltage feedback (Avf) can be used.

The reference signal for both current and speed control can be either bipolar (±10V) or unipolar (0 – 10V). Motor speed can be controlled in both forward and reverse directions. An adjustable current limit and fast-acting current control loop protect the controller and motor from sustained overloads.

2 Safety information

The XLV servo motor controller operates from a supply voltage of less than 60V which means there is a very low risk of electric shock if the user comes into contact with any of the power terminals during operation. However, the controller is capable of producing high current which can cause the load motor and associated machinery to run at high speeds or generate significant heat, or both, if incorrectly configured.

Electric shock risk! Electrical devices constitute a safety hazard. It is the responsibility of the user to ensure compliance with any acts or bylaws in force.

Only install this device if you have the skills and knowledge to use it safely.

3 Connections and LEDs

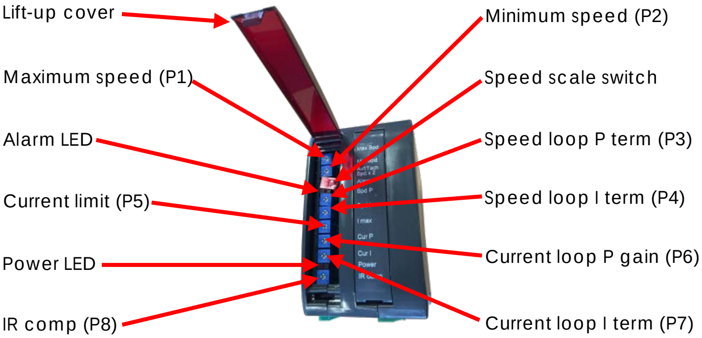

Figure 3-1: User connections

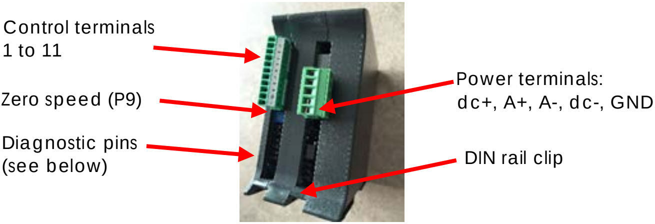

Figure 3-2: Power, control and diagnostic connections (under unit)

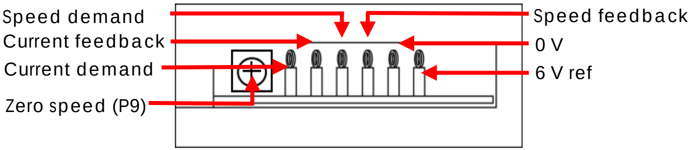

Figure 3-3: Diagnostic pins (adjacent to control terminals)

4 Block diagram

Figure 4-1 shows the key function blocks within the controller.

Note: *There are two nested control loops – an inner current loop and an outer speed loop.*

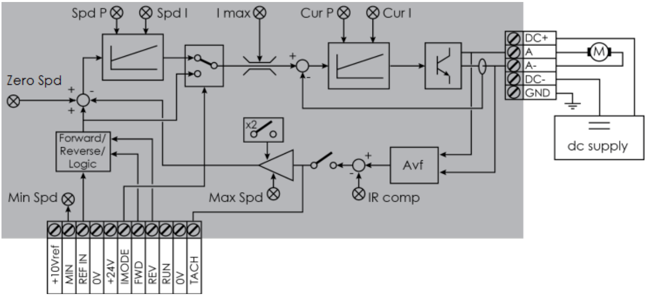

Figure 4-1: Block diagram

The RUN switch must be connected to +24 V for the controller to operate. This is a non-latching input.

5 Installation

5.1 Wiring and protection

Use wire suitable for 1.5 x rated armature current.

The controller must be protected with suitably rated fuses.

5.2 DC power supply

Use a dc power supply appropriate to the voltage rating of the XLV controller being used (12 Vdc, 24 Vdc, 48 Vdc). It must have a current rating at least equal to the full load current of the motor.

5.3 Mechanical design

The XLV controller is designed to clip onto a DIN rail.

Do not expose the unit to excessive vibration and ensure that there is sufficient cooling to keep the ambient temperature below 40 °C.

The maximum dissipation of the controller is 15 watts (1200XLV).

5.4 Load

The XLV controller is designed to control the armature current and shaft speed of a permanent magnet dc servo motor. Although the motor current rating can exceed the current rating of the XLV controller, operation under these conditions will mean that rated torque cannot be achieved. Similarly, the armature voltage rating can exceed the XLV controller voltage but the motor will not be able to run at rated speed.

It is also possible to use the XLV controller to control the current in other inductive loads (e.g. linear actuators). This typically means the controller must be operated in current control mode (see Figure 10-3).

5.5 EMC

According to IEC61800-3 (EN61800-3), the XLV controller is classified as a Basic Drive Module (BDM) only for installation by professional assemblers and for use in the second environment. The drive manufacturer is responsible for the provision of installation guidelines and the manufacturer of the system is responsible for its EMC performance.

5.5.1 Power Port

If the system using the XLV controller will operate in the second environment then a separate filter unit is not normally required.

To meet emissions limits on this port in the first environment, a separate filter is required.

5.5.2 Earthing and Screening

Connect a separate earth connection from the motor frame to the main earth terminal on the controller (terminal 5). Do not ground it to any other earth point.

Connect the drive protective earth on terminal 5 to the star-point earth in the cabinet.

Segregate the DC power and armature power connections from all other cables in the cabinet.

Where screened or armoured cables are used for power connections terminate the screen to earth at both ends of the cable. Only connect control cables of this type at the drive end.

⚠ *Safety earthing always takes precedence over EMC earthing.*

6 Terminal descriptions

6.1 Power terminals

Terminal No.	Name	Description
1	dc +	dc supply to controller
2	A +	Positive connection to motor armature
3	A -	Negative connection to motor armature
4	dc -	Common for dc supply to controller
5	GND	Earth

6.2 Control terminals

The control terminals are all referenced to the negative dc supply to the controller (dc-). All interface signals must be referenced to the same potential.

Section 10 gives further details about the function of the control terminals.

Terminal No.	Name	Description
1	+10 V_{REF}	10 V reference (±0.1%) for terminal 3 (10 mA current limit)
2	MIN SPD	Connection for speed demand pot to set minimum speed (input impedance = 5 kΩ)
3	REF IN	Reference for speed/current (input impedance = 47 kΩ)
4	0 V	Common for reference input
5	+24 V	Supply for driving digital inputs (50 mA current limit)
6	IMODE	Select current (torque) mode – active high (input impedance = 110 kΩ)

Terminal No.	Name	Description
7	FWD	Forward direction select for unipolar reference – active high (input impedance = 110 kΩ)
8	REV	Reverse direction select for unipolar reference – active high (input impedance = 110 kΩ)
9	RUN	Electronic enable for controller – active high (input impedance = 110 kΩ)
10	0 V	Common for tacho
11	TACH	DC tacho-generator input (±60 Vdc max) (input impedance = 150 kΩ)

7 Pre-sets and diagnostics

The following pre-sets (potentiometers) are available for user adjustment under the translucent red flap on the front of the product.

Pre-set	Description
Max Spd	Sets maximum motor speed (in conjunction with speed scaling selection switch)
Min Spd	Sets minimum motor speed (0 to 30% of Max Spd setting)
Spd P	Speed loop proportional gain
Spd I	Speed loop integral time constant
I max	Current limit
Cur P	Current loop proportional gain
Cur I	Current loop integral time constant
IR comp	Compensation for IR drop in motor when running with Avf (0 to 25% of max armature voltage)

All potentiometers are factory-set to a 'safe' condition. This means the gains are at minimum setting.

Note: The current limit is set at approximately 100%.

There is an additional potentiometer, located adjacent to the diagnostic pins, which can be used to adjust the motor speed to zero when the speed reference is 0 V. This prevents shaft "creep" at zero speed.

A switch, located adjacent to the pre-set potentiometers, provides two functions:

- Function 1: Select Speed Feedback Source:
  S1 ON Avf speed control
  S1 OFF Tacho speed control
- Function 2: Select Speed Feedback Scaling:
  S2 ON VA range = 10 – 25 Vdc; Tacho range = 12 – 30 Vdc
  S2 OFF VA range = 20 – 50 Vdc; Tacho range = 24 – 60 Vdc

Two LEDs are provided for diagnostic purposes:

- Power LED: indicates that DC power is applied to the unit and the internal power supply is operational.
- Alarm LED: indicates the presence of an internal fault or trip.

Note: Section 11.1 gives further details on the possible causes of internal trips.

8 Commissioning

Commission the controller with the motor decoupled from the load. If this is not possible, exercise additional caution in the commissioning process to ensure the load is not damaged as a result of the motor rotating in the wrong direction, excessive speed or high vibration from a poorly tuned speed loop.

8.1 Pre-operation Checks

Before applying power to the controller, check the following:

- The dc supply voltage is correct.
- The motor rating (armature current and voltage) is within the rating of the controller.
- All power and control connections are securely made.

- All pre-sets are in their default position (P1, P2, P3, P6 and P8 counter-clockwise, P4 and P7 clockwise and P5 mid-range).

Apply the power. Confirm the following:

- The Power LED illuminates.
- No RUN signal is present (terminal T9 is open-circuit).
- The armature voltage feedback (Avf) is selected as the speed feedback source (Avf/Tach switch ON), even if a tacho-generator will ultimately be used for this purpose.
- Select x1 scaling for maximum speed. This will limit the armature voltage to 25V.

8.2 Start-up Procedure

The next stage in the commissioning process is to run the motor with armature voltage feedback.

1. Apply a positive speed reference of around 10% (1V) to terminal T3.
2. Connect the RUN terminal (T9) to +24 V.
3. Check that the motor is running smoothly in the direction required for a positive speed reference.

8.3 Tacho Commissioning

Operating with tacho speed feedback gives superior dynamic performance and is recommended for all high bandwidth applications.

To commission a motor with tacho feedback, follow the procedure below:

1. Connect <u>one</u> of the tacho wires to terminal T10.
2. Run the motor using the procedure detailed in section 8.2 above.
3. With the motor running measure the voltage on the other tacho wire.
4. If this voltage has the opposite polarity to the voltage on terminal T3, stop the motor, disconnect the power to the controller and connect the wire into terminal T11.
5. If the voltage is the same polarity then disconnect the power to the controller and reverse the two tacho wires.
6. Turn the Avf/Tach switch OFF.
7. Power the controller on.
8. Re-start the motor.
9. Check that the motor is running smoothly in the direction required for a positive speed reference.

Note A rectified AC tacho cannot be used with the XLV controller.

8.4 Tuning and Optimisation

8.4.1 Maximum Speed Setting

Whether running with tacho or Avf, this pre-set is used to set the maximum speed of the motor using the procedure below:

1. Set the speed reference to maximum (+10 V) on terminal T3
2. If running with Avf, measure the voltage on terminals A+, A- and increase the Max Spd potentiometer until the measured armature voltage is equal to that stated on the motor nameplate.

   Note: If the motor's rated armature voltage exceeds 25 V the Spd x2 switch should be set to the OFF position.

3. If running with tacho feedback, increase the Max Spd potentiometer until the voltage measured across terminals T10 and T11 equals the full speed tacho voltage.

   Note: If the maximum tacho voltage exceeds 30 V, the Spd x2 switch should be set to the OFF position.

Avoid changing the position of the Spd x2 switch whilst the motor is running as this will result in a step speed change.

8.4.2 Minimum Speed Setting

With a 10 kΩ potentiometer connected between terminal T1 and T2 and its wiper connected to terminal T3 the minimum speed can be adjusted with the Min Spd pre-set. This connection is shown in section 4.

By increasing the Min Spd potentiometer (rotate CW), the minimum speed can be adjusted up to a maximum of 30% of maximum speed.

8.4.3 Current Limit Adjustment

The current limit pre-set I max is used to adjust the maximum motor current of the controller:

- With the pot fully counter-clockwise the current limit is 0% and the motor will not run.
- With the pot at mid-position the full current of the controller is available continuously (4 amps for 400XLV).
- With the pot fully clockwise the controller will deliver 200% of its rating for one second (8 amps for a 400XLV).

When the overload capability of the controller is used, the current limit automatically reduces to 100% to protect the controller and the motor.

With I max pre-set fully CW, the controller will deliver 200% current for one second and will then reduce its output to 100% within 5 seconds.

8.4.4 IR Compensation

One of the limitations of armature voltage feedback as a method for controlling motor speed is that when under load, Avf is no longer directly proportional to motor speed. To compensate for the effect of load, the IR comp pre-set should be adjusted using the following procedure:

1 Run the motor at full speed and monitor the armature voltage.
2 When the motor is fully loaded, increase the IR comp pre-set (rotate CW) until the armature voltage matches the nameplate value.

Note: Setting the IR comp pre-set excessively high can result in speed instability.

8.4.5 Control Loop Tuning

The XLV controller has two nested control loops: an inner current loop and an outer speed loop. Both use PI (proportional-integral) compensators which each have independent control of the P and I terms.

The controller will function well with the P and I pre-sets in the default position (i.e. CCW for P terms and CW for I terms) but performance may be optimised by adjusting them.

Guidance for tuning the control loops is given below:

1 First optimise the current control loop.
2 Apply small step load changes and increase the proportional gain (Cur P) to improve the speed of response, taking care not to make the current loop unstable.
3 Reduce the integral time constant (Cur I) to reduce over-shoot and settling time.
4 Now optimise the speed loop by applying small step changes to the speed reference and adjusting Spd P and Spd I using the same criteria as for the current loop tuning.

Diagnostic pins are available for monitoring speed and current demand and feedback via an oscilloscope. These are located next to the control terminals on the underside of the unit.

Note: The demand and feedback signals have opposite polarities and are scaled as follows:

Speed: 10V = 100%, 6V = 0%, 2V = -100%
Current: 10V = 200%, 6V = 0%, 2V = -200%

8.4.6 Zero Speed Adjustment

Potentiometer P9 (adjacent to diagnostic pins) provides adjustment to ensure the motor is stationary with a speed reference of zero.

9 Technical specifications

Motor current	4 A (400XLV) 8 A (800XLV) 12 A (1200 XLV)		
Overload	200% for one second (inverse time reduction to 100% in 5 seconds).		
Supply voltage variants	12 V dc (± 5%)	24 V dc (± 10%)	48 V dc (± 10%)
Operating temperature	0 to 40 °C		
Dimensions (H x W x D)	400XLV 800XLV 1200 XLV	105 x 60 x 120 mm 105 x 60 x 120 mm 105 x 70 x 120 mm	

10 Applications

The following diagrams show the basic wiring requirements for the XLV controller in different applications.

Note: Protection circuitry (fusing, motor over-speed, motor over-temperature) are omitted as they will depend on the particular risks identified in the end application.

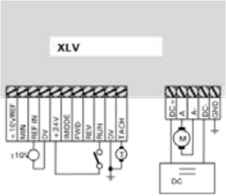

Figure 10-1: Bi-directional speed control with bipolar reference

This configuration would typically be used when an external controller (e.g. a positioning system) provides the speed reference.

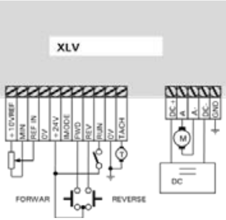

Figure 10-2: Bi-directional speed control with unipolar reference

Note: The switches for forward and reverse running do not need to be latching as this function is within the controller.

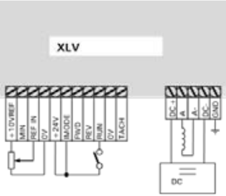

Figure 10-3: Unipolar current control

This configuration can be used for non-motor loads requiring current control (e.g. linear actuators). If operating a motor in this configuration, include measures to limit motor speed under light-load conditions.

11 Troubleshooting

11.1 Trips and alarms

Controller trips may occur during commissioning and normal operation resulting in the controller stopping and the Alarm LED illuminating. The trips that can result in an alarm state are listed below.

Note: *There is no motor over-temperature trip. To protect the motor from over-heating a thermal protection device attached to the motor must be inter-locked with the dc supply to the controller.*

Note: *When any trip occurs, switch the RUN signal on terminal T9 ON to OFF and then back to ON again to re-start the controller.*

If the trip condition persists, it is not possible to re-start the controller. Remove the controller from the system and return it to Sprint Electric Ltd.

11.1.1 Armature over-current (OVERI) trip

The controller will trip on this alarm if the instantaneous current exceeds 250% of the current rating of the particular model. For example, a 4 A 400XLV has a trip current of 10 amps. Typically an OVERI trip occurs when too much proportional gain has been applied to the current loop, when operating at high currents (rapid speed transients and high loads), or less frequently because of a motor fault.

An OVERI trip is characterised by the controller stopping immediately when there has been a large speed or load change. It re-starts immediately.

To remedy an OVERI trip:

- Adjust P6 to tune the current loop proportional gain.
- Disconnect the motor and re-start the controller. If it no longer trips then check the integrity of the motor and wiring.

11.1.2 DC over-voltage (OVERV) trip

When the dc supply to the controller exceeds 60 V, an over-voltage trip will occur. This typically happens when the load is decelerated rapidly and the rotational energy cannot be absorbed by the losses in the motor and controller or the dc supply feeding the unit. This excess energy increases the voltage on the capacitors in the controller and would eventually lead to catastrophic failure if no trip occurred.

An OVERV trip is most likely during rapid deceleration.

*Note: This trip **WILL NOT** protect the controller if a voltage is applied to the unit that exceeds its maximum rating.*

To remedy an OVERV trip, reduce the rate of change of speed reference, or if this is not possible, add more capacitance to the dc supply to absorb the excess energy.

11.1.3 Heatsink over-temperature (OVERT) trip

If the temperature of the XLV heatsink exceeds 70 °C, an over-temperature trip will occur. This generally only happens if there is inadequate airflow in and around the controller. The time it takes for the controller to trip depends on the level of load.

An OVERT trip is most likely when operating for a prolonged period at high load.

To remedy an OVERT trip, establish why there is insufficient cooling and then make any necessary modifications to the installation before re-starting the controller.

11.1.4 Cooling fan failure (FFAIL) trip

Should the cooling fan in the controller stall then this is detected and an alarm is raised. A FFAIL trip is most likely if no air is being blown out of the unit (12 A versions only).

To remedy a FFAIL trip, check to see if air is being blown out of the controller. If this isn't the case, inspect the outside of the unit for foreign objects that may have jammed the blades of the fan.

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