E-600-12, DC-SERVO-AMPLIFIER

8 Ampere Servo-Amplifier for DC-Motors, to be used with the
E-600 Series Motion Controllers.

INSTRUCTION MANUAL

(For version 9715 and newer)

Content:

DIAGRAMS:
- Layout: Conventional component side
- Schematic: #865, #866, #867, #868, #869, #870

July 2003 Edition

1 Short description

The E-600-12 is a low cost module to drive DC-servo motors from our motion controllers in the compact version. The amplifier power is taken from the controller power supply.

The motor must be fitted with an optical encoder for position feedback. A tacho-generator is not required, as the velocity information is derived from the encoder through a frequency-to-voltage converter.

For critical applications, especially when a very smooth motion at low speed is required, a tacho-generator can used in place of the frequency-to-voltage converter.

The motor current can be set to 8 Amperes and the amplifier is able to deliver this current continuously. An I2t circuit protects the motor from excessive heating.

The amplifier has provision for direction dependant limit switches and has over-voltage, over-current and over-temperature protections.

2 Wiring

2.1 Encoder Wiring

The J1 Sub-D female connector is the encoder-input port. It is strongly recommended to have an encoder with line driver outputs, but single ended outputs can be accommodated for with a reduction of the noise immunity.

- With line driver type encoder, use twisted pair shielded cable.
- With single ended drivers, connect the signals to the pins 1, 2, 3. The complimentary pins, 6, 7, 8, are biased at 2,2 V, a suitable bias for TTL levels.

A 5 V Supply for the encoder is available at pin 4, with a return at pin 9.

Pin	Function
1	Encoder Channel A
2	Encoder Channel B
3	Encoder Channel C = Index Pulse
4	+ 5 V supply, 200 mA max.
5	Chassis Ground, connect cable shield here
6	Encoder Channel /A
7	Encoder Channel /B
8	Encoder Channel /C = /Index
9	0 V, supply return

Table 2-1 : Encoder Wiring

2.2 Motor and Limit Switch Wiring.

The J4 Burndy connector has pins for the motor armature, the limit switches and, optionally the tacho-generator. Thus, separate shielded cables must be used for the different functions. If the motor wires are not shielded, it is mandatory to shield the limit switch wires, especially if proximity detectors are used. The tacho signal must be shielded in any case.

The shields must be tied together and connected to a piece of flexible wire with an eyelet to be connected to the back panel M5-screw. In this manner, a continuity of the electrical enclosure is realized.

See the set-up procedure for the polarity of the armature wiring.

The limit switch inputs have 4.7 kOhm pull-down resistors and a smoothing time constant of 50 us. Use normally closed contacts with their common at 12 V (Pin E). 24 V input signals are also acceptable. The 12 V pin is current limited by a 330 Ohm serie resistor.

If the limit switches are not used, short the input pin to 12 V.

Pin	Function
A	Motor Armature
B	Motor Armature
C	(Tacho-Generator Signal)
D	(AGND, Tacho Return)
E	+ 12 V, current limited
F	0 V, for prxmty switches
G	Backward Limit Switch
H	Forward Limit Switch

Table 2-2 : Burndy Connector Wiring

3 Motor selection and personalization of the servo amplifier

3.1 Motor Selection, Supply Voltage

Within the E-600 Controller, the E-600-12 can be hooked-up at the 24 V or 70 V supply. Soldering a wire jumper does the voltage selection (see layout diagram).

The maximum available armature voltage will be about 2 V under the supply voltage. The motor must be able to run at the required speed at the available voltage. Motors designed for lower voltages are acceptable provided the armature inductance is high enough. Too low an inductance produces a high ripple current, which leads to large heat generation in the motor and, eventually, to an overload of the amplifier.

The peak-to-peak value of the ripple current is:

$I_{ripple\ pp} = 0.6/L$ for the 24 V supply,

$I_{ripple\ pp} = 1.75/L$ for the 70 V supply,

Where L is the armature inductance in mH and Iripple in A.

3.2 The Test Points

Refer to Layout diagram.

TP3: Analog Ground.

TP2: Armature current, 0.8 V/Ampere.

TP1: Velocity Feed Back.

TP0: Position Error, +/- 5 V for the whole linear range. i.e. 10 mV per unit of digital position error. (When using the SERVO debugging menu of the E-600 controller, the voltage at TP0 is half the displayed value).

4 How to start a servo drive?

A major problem while setting-up a servo-system is the consistency of the directions of rotation of the motor, the encoder and, eventually, the tacho-genrator.

The set-up has to be done with the motor shaft disconnected from its load and the armature wires open.

Then proceed as follows:

1. Enter the DEBUGGING menu (UNIPROG system program) and select SERVO with the F3 key.

   Screen:

P-ERR 0 =		**0.001**	
CHA	**POSL**	**ENB**	**HIGH**

   The 4 function keys have toggle action:

   F1 Selects the servo-channel.

   F2 Opens the position loop and the upper line now shows the analogue output, assuming a +/-10 V range.

   F3 Toggles the ENABLE command to the power amplifier on and off.

   F4 Toggles the MODE control. With the E-600-12 the "Low Gain Mode" must be set (default mode).

2. Press F2 and F3 to open the loop and to disable the power.

3. Now connect the armature leads.

4. Press CLR to set the analogue output at 0 V.

5. Enable the amplifier (F3). If the motor starts running at high speed, press F3 again and permute the armature connections. Enable the amplifier again, the motor must be at rest or running slowly. **Cancel the offset with the OFFSET trimmer**.

6. Depress F2 to close the position loop. Without tacho-generator, all connections must be ok. With a tacho-genrator, the counting direction of the encoder may still be wrong

and the motor runs aways. Disable and permute A with /A (or A with B for a single ended encoder).

4.1 Servo-loop adjustment

Now the servo-loop can be trimmed to insure stability and to get the most desirable response.

In the close position loop, program a reciprocating motion. Start with a moderate numerical gain (6000).

- Turn the compensation trimmer CCW until the current show instabilities, then 2 revolutions CW.
- Adjust Velocity feedback and compensation trimmer to obtain the optimum response. Overshoots are canceled by giving more velocity feedback.
- The tracking error can be read on the display. Try to work with a higher numerical gain to reduce the tracking error.
- While the motor is at rest, readjust the offset to have a zero error on the display.

4.2 Current Setting

The potentiometer I_{max} sets the maximum current the amplifier will deliver to the motor. The range is from 0 to 8 Ampere. Remember the scale factor at TP2 is 0.8 V per Ampere.

This current is factory adjusted at 5A (4V at TP2). To adjust other values, proceed as follow:

- In the Debugging/Servo menu of the E600, enable POSL and ENB (F2 and F3 led ON).
- Place a scope between TP3 (GND) and TP2 (I).
- Displace motor axe out of his rest position until current stop increasing. Read current value on the scope (U=0,8*I) and adjust it. The maximum current is 8A (6,4V at TP2).

4.3 I^2t setting

The I^2t circuit integrates the squared current into a capacitor. When the voltage across the capacitor reaches the threshold, the current fall to zero and the red LED is on. In normal operation, the LED must stay off.
This circuit is factory adjusted to disconnect the motor 10 to 20 seconds after a functioning at 5A.