INSTALLATION MANUAL

NE2110, NE2120
D.C. SERVO CONTROLLERS

NORWIN ELECTRONICS LIMITED
Unit 6, Industrial Estate,
Station Road,
Gamlingay,
Sandy,
Bedfordshire.
SG19 3HB

Telephone: 01767 651485
Fax: 01767 651623

Nov 2002 : Subject to change without prior notice

TABLE OF CONTENTS

1. INTRODUCTION

The purpose of this manual is to provide the necessary basic information for the set up, operation and troubleshooting of the Norwin Electronics Type NE2110 and NE2120 Servo Controllers. Operating personnel should be familiar with the contents of this manual before any connections are made to the drives or their supporting equipment. This manual does not cover every possible contingency to be met in connection with installation, operation or troubleshooting. Should further information be required or should problems arise which are not dealt with in this manual contact Norwin Applications Engineering Staff.

The NE2110 and NE2120 are transistorized PWM Servo Controllers and are intended for use as controllers of brushed dc permanent magnet servomotors. The normal command signal source is the analogue output (error signal) of a CNC or Motion Controller. Typical applications of these controllers are machine tool feed drives and robot axis drives.

2. RECEIVING AND HANDLING

Upon delivery of the equipment, thoroughly inspect the shipping containers and contents for indications of damage incurred in transit. If any of the items called for in the delivery receipt are damaged or the quantity is short, do not accept them until the delivery agent makes an appropriate notation on the delivery receipt. If any concealed loss or damage is discovered later, notify the delivery agent within 15 days of receipt and request that an inspection is made.

Store the equipment in a clean, dry area. It is advisable to leave the equipment in its shipping container until ready for use.

3. SPECIFICATIONS AND GENERAL DESCRIPTION

3.1 ELECTRICAL SPECIFICATION

BASIC SPECIFICATION

	2110	2120	
Bus Voltage (maximum)	100	180	volts
Bus Voltage (minimum)	24	24	volts
Peak Output Current	30	30	amps
Continuous Output Current	15	15	amps
Minimum Armature Circuit Inductance	1.5	2.0	mH
Switching Frequency (nominal)	10	8	kHz
Torque Amplifier Bandwidth	1	1	kHz
Form Factor (typical)	1.01	1.01	
Torqueless Zone (Deadband)	nil	nil	
Operating Temperature	0 to 50	0 to 50	°C

3.2 OUTLINE DIMENSIONS

The servo is constructed using a double eurocard format with a card height of 233,4 mm and a card width of 160 mm. Figure 1 shows the profile of the card.

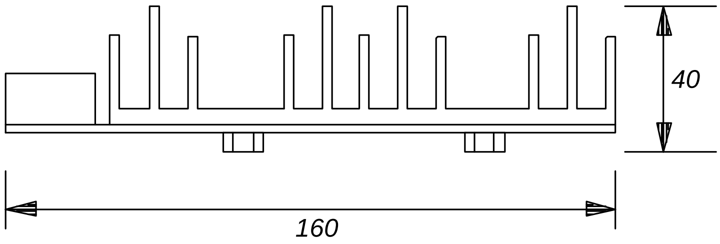

Figure 1

3.3 TERMINAL DESCRIPTIONS

TB	PIN	DESCRIPTION
1	1	DC Bus +
	2	DC Bus Common
	3	Armature Output +
	4	Armature Output –
2	1	+24V dc Input
	2	0V
	3	–24V dc Input
3	1	Tach Lo
	2	Tach Hi
	3	–15V dc (Available for external use @ 100mA max.)
	4	0V
	5	+15V dc (Available for external use @ 100mA max.)
	6	Limit Input (Positive Over-travel)
	7	Limit Input (Negative Over-travel)
	8	Enable Input
	9	Fault Output
	10	Command Lo
	11	Command Hi

3.4 BUS SUPPLY

In general the dc bus supply will be obtained from one of the standard Norwin racks. Where a standard Norwin rack is not used it is essential to ensure that:

(a) The dc bus wires have an adequate current carrying capacity.
(b) The length of the wires from the main smoothing capacitor to the servo controller are kept as short as possible.

For all rack arrangements great care must be taken to ensure that:

(a) The correct transformer taps are selected to keep the bus voltage within its specified limits.
(b) The correct polarity voltage is applied to the bus input terminals i.e.

TB1	Pin 1	Bus +
TB1	Pin 2	Bus common

INCORRECT CONNECTION MAY RESULT IN DAMAGE TO THE UNIT !!!!!

3.5 AUXILIARY SUPPLIES

In order to provide the control voltages for operation of the servo controller the unit needs to be provided with the following low voltage supplies:

TB2	Pin 1	+24V dc
	Pin 2	0V
	Pin 3	–24V dc

3.6 COMMAND INPUT

In the normal mode of operation the command input is used as the control signal for the speed of a permanent magnet dc servomotor fitted with a dc tacho-generator. Alternatively, by fitting a "current-mode" personality module, this input may be used to directly control the armature current of the motor and thereby the torque.

Figure 2 shows the command input circuit configuration. The command input has the form of a differential amplifier. This aids the suppression of common-mode noise on the input leads.

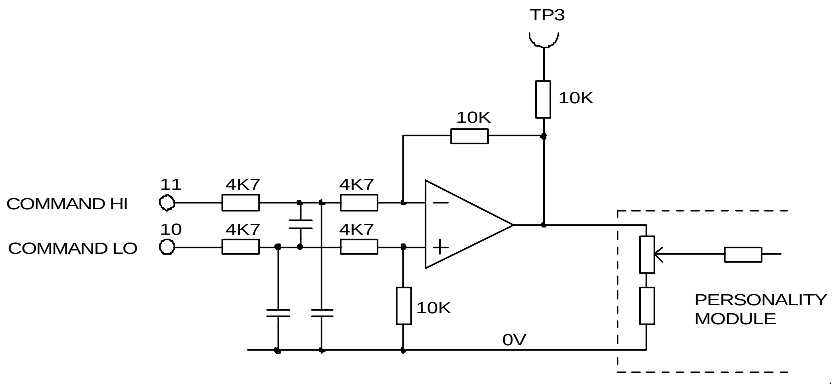

Figure 2

Where a differential input stage is not required, single-ended operation is obtained by simply connecting the Command Lo input to 0V and the signal to the Command Hi input. If the signal has the wrong sense then connect the Command Hi input to 0V and the signal to the Command Lo input.

Careful attention must be paid to the screening of the command input leads. In general the Command Hi and Command Lo signal leads should be a screened twisted pair with the screen being connected to 0V at the signal source end.

3.7 TACH INPUT

When operating in the speed control mode an analogue speed feedback signal is required. In general the servomotor will be fitted with an integral tacho-generator for this purpose. In some cases the tacho-generator may be mounted remotely from the motor. With remotely mounted tacho-generators it is important to ensure that there is a good mechanical coupling between the motor and the tach to minimize the possibility of instability.

Figure 3 shows the tach input circuit configuration. Unlike the command input, this is a single-ended input with a simple R-C filter to reduce the noise inherent in the tach signal.

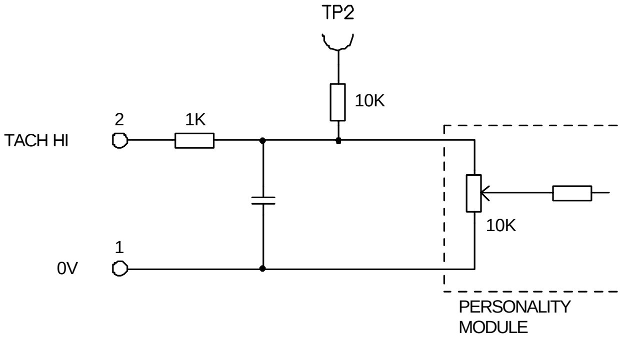

Figure 3

The tach leads should be a screened twisted pair with the screen earthed to the equipment mounting plate at the servo end (see section 4).

The maximum voltage between Tach Hi and Tach Lo should not be greater than ± 50V.

The input impedance of the tach circuit varies according to the setting of the tach gain pot and is between 7875 ohms and 11000 ohms.

3.8 TOTAL ENABLE

Figure 4 shows the configuration of the Total Enable input circuit.

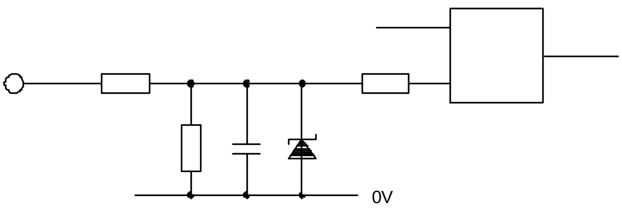

Figure 4

The servo controller is enabled when the voltage at the Enable input is between +15V and +24V. When the input signal is removed, operation of the servo controller is disabled.

3.9 LIMITS (POSITIVE AND NEGATIVE OVER-TRAVEL)

The operation of the Positive and Negative Limits is similar to that of the Total Enable except that each limit input controls only one half of the output bridge circuit. This means that by control of the limit inputs the motor can be constrained to motion in one direction only making them suitable for use as over-travel limits.

Each of the limit inputs is identical to the enable input circuit and is shown in Figure 4.

To enable operation of the motor in both directions the limit inputs should be connected to a voltage between +15V and +24V. Removal of a limit input signal inhibits operation of the motor in that particular direction.

3.10 FAULT OUTPUT

The fault output circuit, which is shown in Figure 5, comprises an open-collector NPN transistor where the emitter is connected to the servo 0V. The transistor is capable of switching a load current of 75mA with supply voltages up to 26V dc. Inductive loads should be fitted with diode clamps to prevent higher voltage transients appearing across the output terminals.

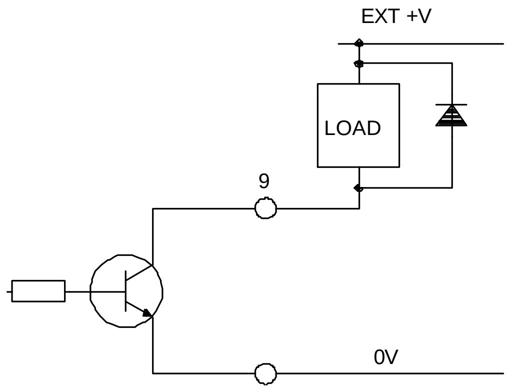

Figure 5

During normal operation the output transistor is turned on. Once a fault occurs the condition is latched in the control circuit, the drive is disabled and the fault output transistor is turned off. A visual fault indication is given with the red LED on the front edge of the board.

There are three possible reasons for a fault being detected viz.

(i) Armature over-current
(ii) Armature short-circuit
(iii) Heatsink over-temperature

Once the fault has been cleared the fault latch can only be reset by the removal of the logic supplies. When the supplies are re-applied the red LED should no longer be on.

4. INSTALLATION

WARNING
Dangerous power levels exist in the NE2110 & NE2120 controllers and all associated equipment. Only qualified personnel should work on this equipment. At all times during the initial set-up, be prepared to remove power if a mechanical or electrical problem occurs.

4.1 GENERAL

A successful system installation, from both a performance and a personnel safety standpoint, requires a properly engineered application with regard to details of system wiring, grounding, noise suppression, the use of necessary ancillary components, such as armature inductors, load contactors, protective devices, and conformance to local electrical codes, etc.

4.2 MECHANICAL INSTALLATION

As previously mentioned the servo controllers are mounted in racks. The racks provide all necessary power supplies and also have a fan which force cools the entire assembly. The racks are designed to be panel mounted vertically with the fan situated at the bottom. Other items of equipment that are mounted adjacent to the rack should be sited so as not to impede the flow of air through the rack.

4.3 ELECTRICAL INSTALLATION AND EMC GUIDELINES

4.3.1 GENERAL

The NE2110 and NE2120 servo controllers are single card assemblies that are intended to be incorporated into machine systems. In order for the servo controllers to function they require the following items of equipment to be included in the overall system:

(a) A three-phase or single-phase mains transformer.
(b) A power supply to produce the dc bus and auxiliary supplies.
(c) A rack to house the servos, complete will fan for forced cooling.
(d) A brushed dc permanent magnet motor, complete with tacho-generator
(c) A source for the analogue control signal to the servo.
(d) An enclosure in which the equipment is housed.

A typical system is shown in Figure 6.

The EMC performance of the servo is inextricably linked with the overall EMC performance of both the other components in the system and the way in which the system is assembled. To ensure that the overall system meets the appropriate harmonized standard for EMC emissions and immunity (e.g. EN 50081-1 for emissions and EN 50082-2 for immunity) the system builder must pay particular attention to the way in which the system is constructed. The following guidelines should assist in the production of a system that complies with the regulations.

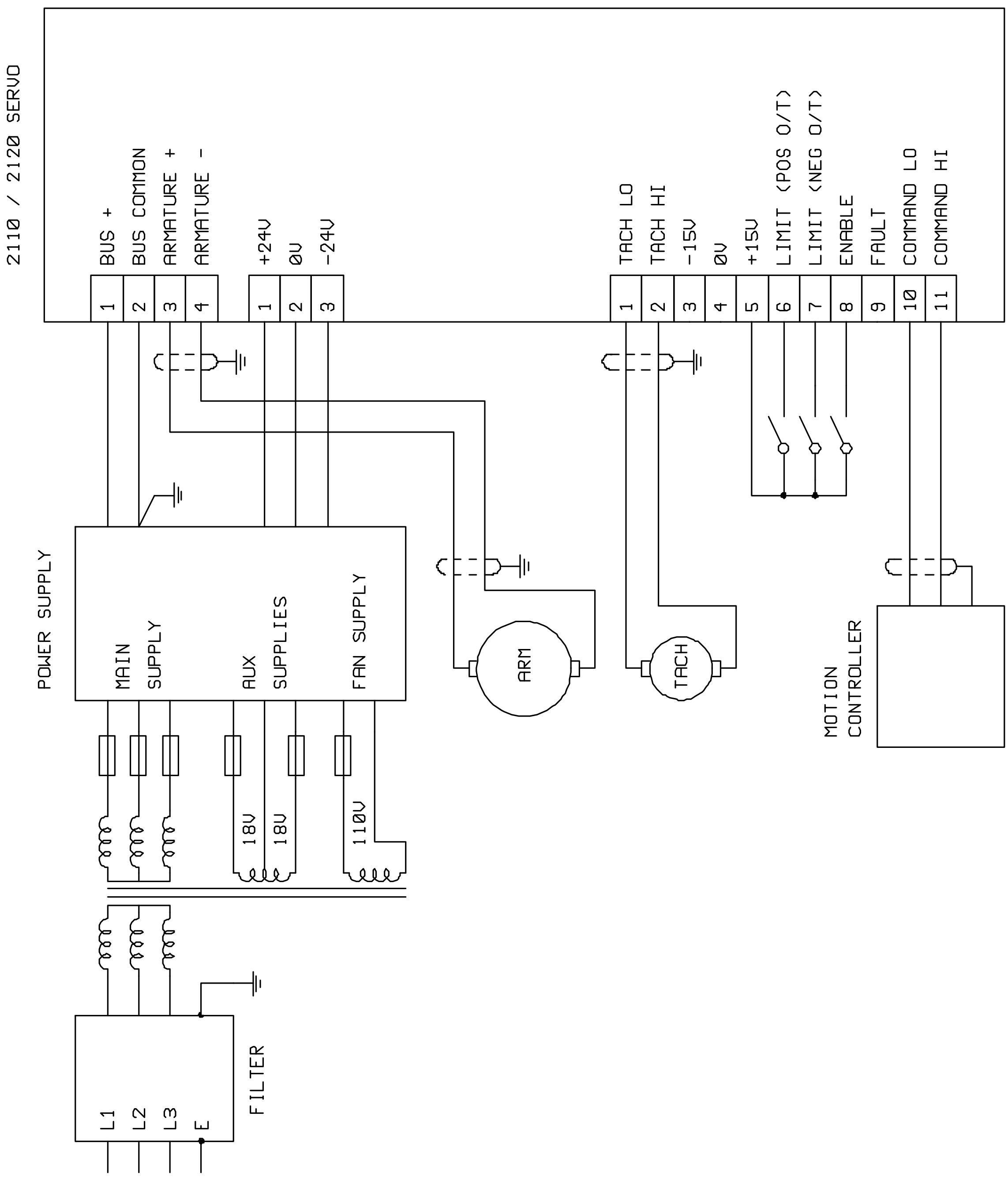

Figure 6

4.3.2 EARTHING

- The system must conform to local electrical codes regarding earthing.
- Use earth conductors with the largest possible cross-sectional areas.
- Keep all earth connections as short as possible.

4.3.3 FILTERING

- The use of a high performance filter can greatly reduce the conducted emissions seen on the power lines. A number of manufacturers produce filters specifically designed for motor drive systems.
- Choose a filter with a current rating appropriate to the system.
- Bond the case of the filter directly to the equipment panel. There should be no paint or other coating between the filter and the panel.
- Keep the "clean" supply leads to the filter away from noisy leads such as armature cables, unfiltered power cables etc.
- Make the "clean" supply leads to the filter as short as possible.
- It should be noted that the earth currents flowing due to the filter capacitors may prevent the use of RCD protection devices.

4.3.4 SCREENING

- The motor armature and tach leads should use screened cable. The armature screen should be earthed at both the motor end and also at the servo end. The screens should be earthed to the equipment mounting plate using either brass P-clips or U-clips (or some other similar clamp) and not by forming a pigtail. See Figure 7.
- The equipment enclosure forms the overall screen for the drive rack, which itself has no intrinsic screening properties. All of the panels that make up the enclosure should be bonded together to provide a low impedance at high frequencies - short braided links are preferred for this.
- Where possible the motor cables should be run in metal conduit.

4.3.5 FERRITES

- A dc commutator motor, even when operating directly from a dc supply, is a source of conducted RFI. The use of a ferrite ring or clamped ferrite core on the armature leads can reduce the higher frequency emissions by as much as 10dB.
- Further attenuation of conducted RFI (at the higher frequencies) can be achieved by putting a ferrite core over the supply leads (but not the earth lead) at the input of the mains filter.

4.3.6 OTHER CONSIDERATIONS

- DC power bus connections, together with the ± 24V dc supplies, from the power supply to the individual drive cards should be kept as short as possible.

- Power cables should be sized against the requirements of the servo controller and its power supply, not the motor.

- Signal wires should use screened cable wherever possible and be run separate from the power cables. The command screen should be connected to the signal source common at the signal source end. There may be situations where, because of the configuration of a particular system, these guidelines are not applicable. If problems arise then advice may be sought from the Norwin Applications Engineering Staff.

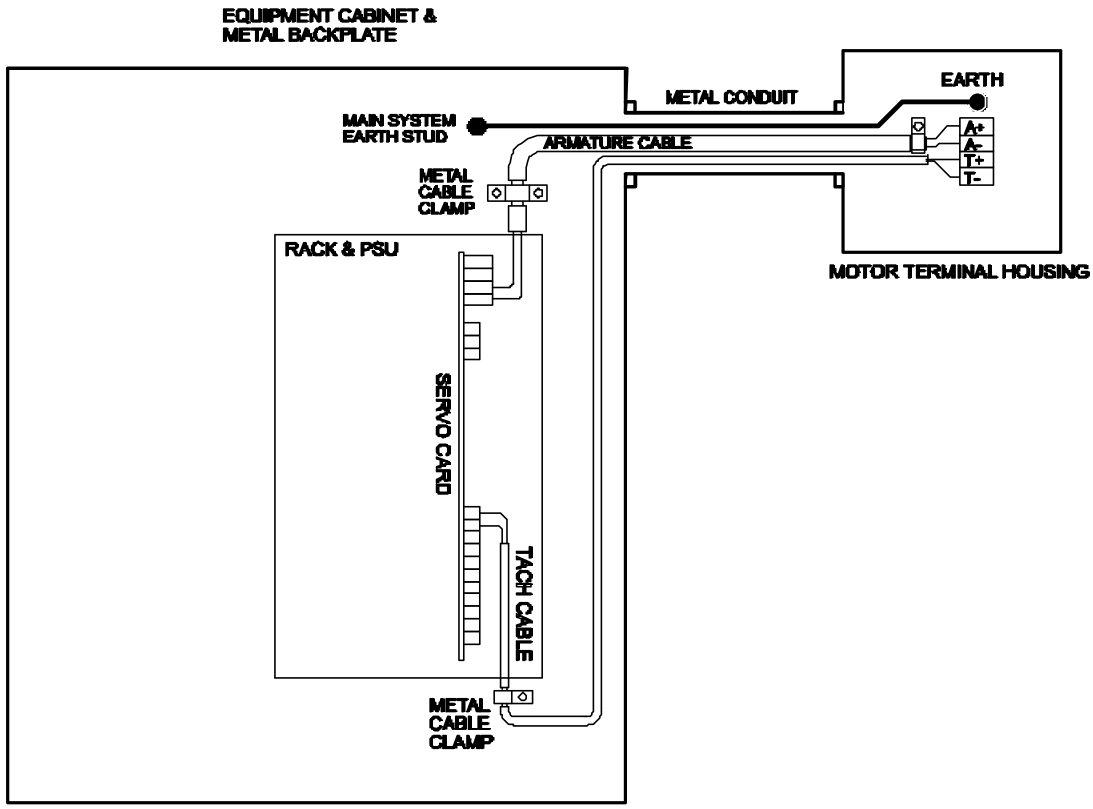

Figure 7

4.4 VISUAL INSPECTION AND WIRING TESTS

With the installation and wiring finished, perform the following checks:

- Check and secure all connections to the motor and feed-back units. Verify that the mechanical system is not obstructed in any way.
- Check fuses to verify proper size and type throughout the drive system.
- Check phasing of each axis armature, tach and signal wiring leads. Incorrect phasing can cause a motor runaway condition.
- Check that the taps on the power transformer are set to give the correct nominal dc bus voltage for the equipment in use.
- Check operation of the axis Enable and Limit switch signals.
- If a motor loop contactor is to be used, it is important that the enable signal of the servo controller is interlocked with the operation of the contactor. This can be done by using an auxiliary N.O. contact connected in series with the controller enable circuit.

5. AXIS SET-UP

5.1 GENERAL INFORMATION

CAUTION

Extreme care must be exercised when applying these procedures to machine mounted motors to avoid incurring damage to the machine, drive and/or motor. If at all possible the initial set-up should be performed with the motor decoupled from the machine and/or drive components.

To minimize the amount of setting-up required during commissioning or when replacing a drive on site the majority of the adjustments have been incorporated on a removable personality module. This means that when a drive is replaced on site it is simply necessary to take the personality module from the old drive and fit it on to the new drive. The only adjustments that remain to be done are for Offset and Gain. These are altered by means of two pots, the Offset pot being on the main pcb and the Gain pot being on the personality module.

A range of personality modules are available, some having potentiometers allowing adjustment at any time and some having fixed value components chosen to suit a particular motor/load combination.

Figures 8 and 9 show the outline of the personality module identifying the location of all components both for the version having fixed value components and for the version having potentiometers. Figure 10 shows the circuit diagram of the personality module.

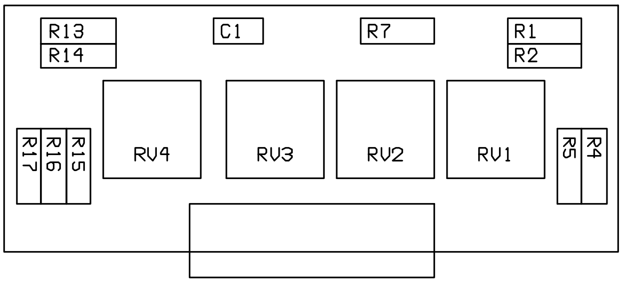

Figure 8

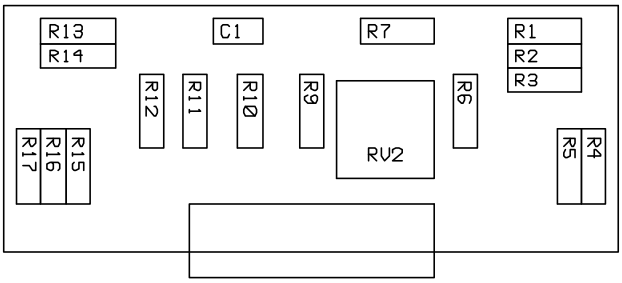

Figure 9

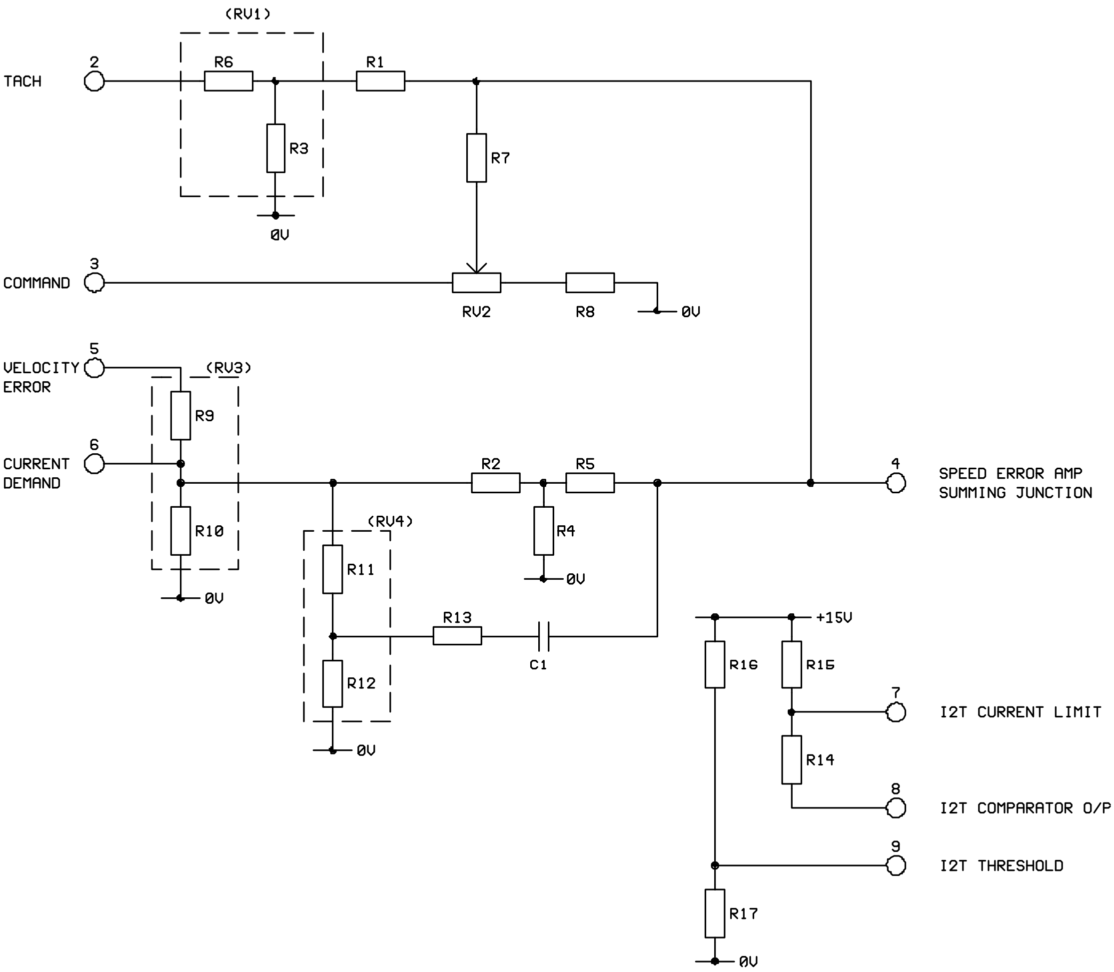

Figure 10

Figure 11 shows the personality module mounted on the main pcb with all the potentiometer functions identified for easy reference.

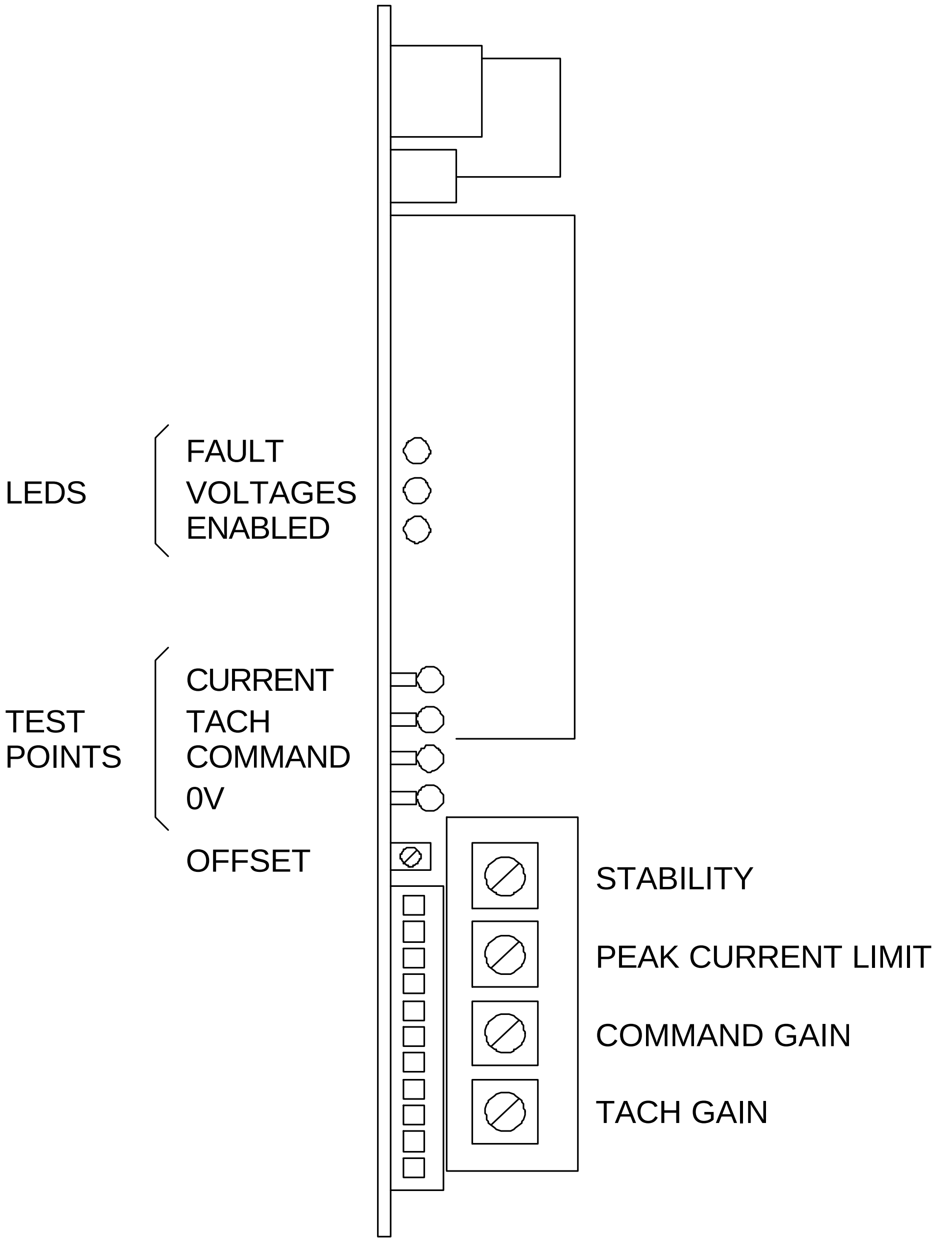

Figure 11

By changing components or adjusting pots the following parameters can be set:

(i) COMMAND GAIN
(ii) TACH GAIN
(iii) PEAK CURRENT
(iv) CONTINUOUS CURRENT
(v) VELOCITY STABILITY

5.2 AXIS SET-UP (FIXED PERSONALITY)

(a) Fit the personality module on the 10-way header with the component side facing towards the front edge of the main pcb

(b) With a zero speed command and the drive disabled, apply power to the unit. Check the three status LED's:

RED	OFF
YELLOW	ON
GREEN	OFF

(c) Enable the drive and check that there is no rapid acceleration of the motor, the motor shaft should remain stationary or drift slightly in either direction. If a runaway condition exists it is most likely a result of the motor armature or tach leads being incorrectly connected. Check the three status LED's:

RED	OFF
YELLOW	ON
GREEN	ON

(d) Still with a zero speed signal command, adjust the Offset pot (RV1 on the main pcb) until any rotation of the motor shaft ceases.

(e) Input maximum speed command voltage. Monitor the motor speed. Adjust the command gain potentiometer (RV2 on the personality module) until the desired maximum speed is obtained.

5.3 PERSONALITY MODULE ADJUSTMENTS

5.3.1 COMMAND GAIN

In some situations it may be necessary to scale down the command signal in order to reduce the top speed of the motor. This is done by adjusting the potentiometer RV2 on the personality module.

A facility is also provided where the range over which RV2 operates is limited to some proportion of the total range. The range can be limited by increasing the value of resistor R8 on the personality module. By using this facility the sensitivity of RV2 is increased making setting-up easier.

5.3.2 TACH GAIN

Resistors R6 and R3 (or potentiometer RV1) form a potential divider network which, together with R43 on the main pcb, scale down the feedback voltage from the tacho-generator on the motor. Their values should be chosen so that when the motor is running at the maximum desired speed, the voltage at the junction of R1,R3 and R6 (Vx) is approximately equal to the voltage which is to be output from the CNC controller (or similar device) to command such maximum speed.

$$V_x = V_{tach} \times \frac{R3'}{R3' + R6 + R43}$$

Where R3' is the equivalent of R3 in parallel with R1.
R43 is fixed at 1000 ohms

5.3.3 PEAK CURRENT

The basic specification of the drive states that there is a peak current capability of 30A. This peak current is sustainable for a duration dependant on a number of factors viz.
(i) i2t threshold level.
(ii) Previous level of current prior to peak demand.

In certain circumstances it may be desirable to reduce the level of the peak current to suit a particular motor. The potential divider network formed by R9 and R10 (or RV3 if fitted) sets the peak current level.

$$I_{pk} = 30 \times \frac{R10'}{R9 + R10'}$$

Where R10' is the parallel combination of R10 and 22000 ohms. The sum of R9 and R10 should be less than 10k ohms.

5.3.4 CONTINUOUS CURRENT

The continuous current level is controlled using two separate parameters viz.
(i) i2t threshold level
(ii) i2t foldback level

The basic function of these circuits is as follows. Firstly an approximation to the square of the armature current is integrated with respect to time using a simple R-C network. This gives an approximation to the rms current in the armature. If the rms current exceeds the i2t threshold level then a comparator switches and forces the current limit to fall to the level set by the i2t foldback level. This reduced current limit stays in operation until the rms current falls below the comparator threshold level. A small amount of hysteresis is incorporated in the comparator circuit to minimize oscillations between the two current limits.

Note: if link LK5 is fitted then the i2t comparator activates the fault latch rather than reducing the current limit.

(a) I2T THRESHOLD

The threshold level for the i2t comparator is set by resistors R16 and R17.

$$V_{th} = 15 \times \frac{R17}{R16 + R17}$$

Figure 16 gives a graph of threshold voltages (V th) against the range of continuous current levels. Using the graph and the equation above, values for R16 and R17 can be chosen.

(b) I2T FOLDBACK LEVEL

Once the i2t comparator detects that the threshold has been exceeded it changes state and causes the current to fold back to a level set by R14 and R15.
The foldback level should be chosen in conjunction with the threshold level to avoid oscillations between the peak level and the foldback level during an i2t over-current condition.

Depending on the setting of links LK3 and LK4 it is possible to set the fold-back current either as a ratio of the peak current as defined in section 5.3.3 or as a ratio of 30 amps.

$$I_{fb} = \frac{I_{ref}}{10} \times \left(\frac{14.8 \times R14}{R14 + R15} + 0.9 \right)$$

If LK3 is made then Iref = I peak
If LK4 is made then Iref = 30 amps

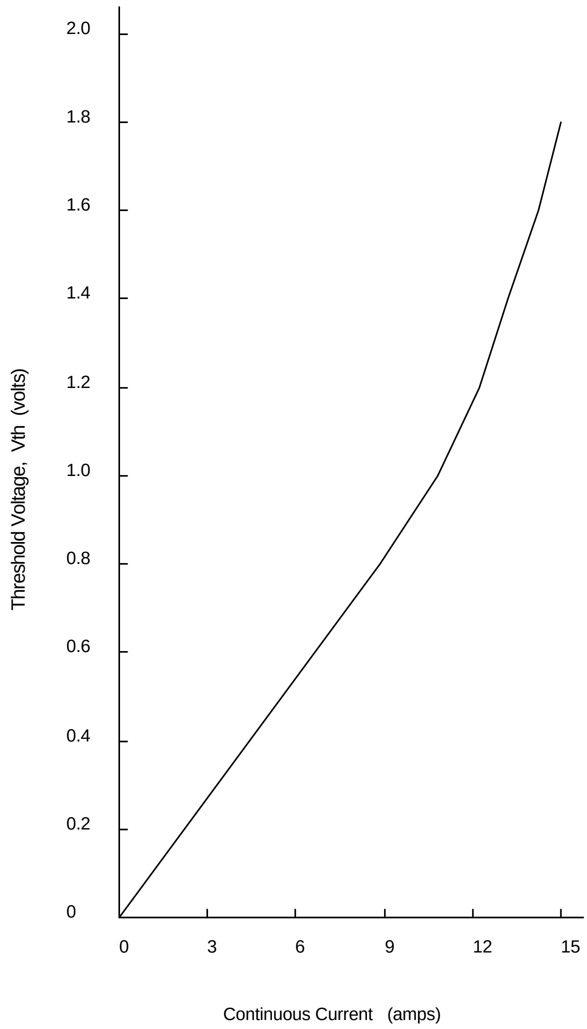

Figure 16

5.3.5 VELOCITY STABILITY

The velocity stability function is performed by a lag-lead feedback network around the velocity error amplifier (part of IC2 on the main pcb). Stability can be altered in two ways. Firstly, by adjusting the value of the feedback components, C1 and R13 and secondly by varying the ratio of the output voltage that is applied to the feedback network. This ratio is set by resistors R11 and R12 (or RV4 if fitted). For many applications it is sufficient to carry out these adjustments empirically. However, once obtained for a particular motor/load combination they should remain valid for all drives in similar applications.

In more critical applications a mathematical approach needs to be adopted. This, however, is beyond the scope of this manual.

5.4 OFFSET ADJUSTMENT

The offset pot is situated on the main pcb (not on the personality module). To adjust the offset, set the command input to zero volts and adjust the pot until rotation of the motor shaft ceases.

It is important to remember that the offset adjustment on the servo controller is there to compensate for any offsets in the speed loop when the command input voltage is zero. It should not be used to compensate for other offsets that may be present in the system; these should be adjusted separately.

6. TROUBLESHOOTING

CAUTION

Whenever any maintenance or troubleshooting is attempted, extreme caution must be exercised. Potentially lethal voltages exist within the controllers and their auxiliary assemblies. Only qualified personnel should work on this equipment.

6.1 FAULT DETERMINATION PROCEDURES

CONDITION	FAULT ACTIVATION	PROTECTIVE ACTION
Over-temperature	Heat sink temperature > 100 °C	Fault latch activated.
Armature short	Instantaneous upon S/C	Red LED on.
Peak over-current	Output current >48A	
Bus over-voltage	NE2110 : DC Bus >135V NE2120 : DC Bus >210V	Drive inhibited until fault clears.
Bus under-voltage	DC Bus <12V	Yellow LED off.
Logic supplies U/V	Logic supplies <13V	Green LED off.

6.2 FACTORY REPAIR SERVICE

Norwin do not advise field repair of the NE2110 and NE2120 servo controllers. Defective units should be returned to the machine manufacturer or, with his advice, to Norwin Electronics Ltd. or their appointed agents.

(a) Collect the following information when returning a defective unit:
- Serial Number.
- Reason for return / description of problem.

(b) If the unit has been disassembled, reassemble it making certain that all the hardware is in place.

(c) Tag the unit with the following:
- Serial Number.
- Company and company representatives returning the unit.
- Date of return.
- Any pertinent, helpful information regarding the malfunction.

(d) Carefully package the unit and apply appropriate cautionary stickers (e.g. FRAGILE).

6.3 SPARE PARTS

The NE2110 and NE2120 are, for the most part, complex electronic units and repairs require a thorough understanding of electronic principles and a full complement of electronic test equipment. Because of this and also because of the factory repair service offered the only recommended spares are complete replacement units together with a range of personality modules covering the most common applications.