EUROAMP/10

Hardware Installation Guide for EuroAmp/10 Servo Amplifier

Issue 1.3

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Revision History

Issue	Revision	Date	Reference	Comments
1	000	July 93	ea10_2.doc	First release of hardware manual for NextMove
1.1	001	July 94	ea10_3.doc	p3 GND pin5 changed to pin6 p4 Backplane diagram updated to EuroAmp/10 p7 β changed to 0.8 (from 0.9) p9 Calculation changed for β = 0.8 p9 Tacho range added p15 3k6 changed to 10k, R44 deleted p16 R44 note added p26 Discussion of LP4
1.2	002	Dec 94	ea10_4.doc	R44 10k for tacho feedback
1.3	003	May 95	ea10_4a.doc	Updated for clarity

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Preface

This manual describes how to configure EuroAmp/10 issue 2 as a current or velocity amplifier including details of pin-outs on the rear connector and the back plane.

If you are using EuroAmp/10 with the EuroSystem controller, you are recommended to read the EuroSystem Hardware Reference which covers mechanical wiring details for EuroSystem.

Please read all sections of this manual before using EuroAmp/10.

1. Introduction

1.1 Hardware Overview

EuroAmp/10 is an advanced 750W DC servo amplifier available in a single (3U) EuroCard format and is ideally suited to use with the Optimised Control EuroSystem servo controller. EuroAmp/10 is suitable for driving motors rated up to 65V, 10A continuous, with a peak output current of 20A; there is no i^2t limiting. Only a single AC or DC power source input is required, to supply the motor power stage and provide all necessary voltages for onboard control functions. In addition, ancillary voltages of +5V, +12V, and -12V are available to the user for connection to external controllers such as EuroSystem.

In its standard format EuroAmp/10 is configured as a current mode amplifier.

Two industry standard +/- 10V inputs , DEMAND and AUXILIARY, provide a flexible input scheme that allows EuroAmp/10 to integrate easily into many system applications. A comprehensive protection scheme guards the amplifier against:

- over-temperature
- over-current
- under-voltage

External enable inputs allow remote cut off of the motor power stage. Two directional limits '!ENCW' and '!ENACW' disable the amplifier in one direction or the other. This allows stand alone operation from a joy-stick or other direct interface, while still allowing powered motion away from end of travel limits. A master Enable signal is also available. An ERROR output signal indicates when a fault condition exists.

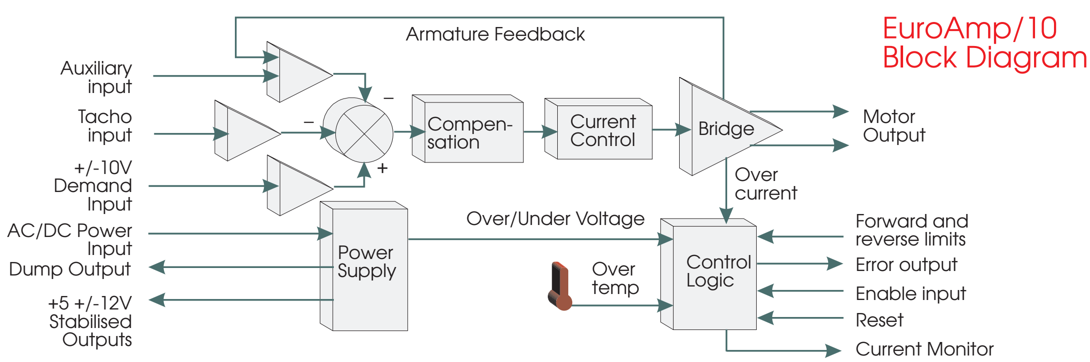


Figure 1.1: EuroAmp/10 Block Diagram

1.2 Summary Of Features

- Full four quadrant output stage
- Single AC or DC power input
- Current amplifier configurable as velocity controller
- Tacho or Armature (IR) velocity feedback modes
- Two fully differential inputs
- Easily adjustable DC and AC velocity gains
- On-board ballast circuit with full external dump capability
- External ENABLE input, and ERROR output for connection to intelligent systems
- Directional limit inputs for direct joy-stick connection
- Comprehensive protection scheme

2. Hardware Connections

Commissioning EuroAmp/10 firstly involves the connection of a power supply, analogue input signals, motor and an optional power dump resistor. All connections are made via a 31 pin, DIN41612MH male connector and you are recommended to purchase a backplane board for this purpose.

For large volume OEM applications direct connection to EuroAmp/10 may be made with a DIN41612MH female connector. Both discrete wire and PCB mount connector types are available from the following manufacturers:

- Harting Elektronik Ltd, Biggin Hill, Kent, TN16 3BW
- Souriau (UK) Ltd, High Wycombe, Bucks, HP10 9QY

A low profile version is available from:

- 2E (UK) Ltd, Ashton-in-Makerfield, Lancs, WN4 9AG

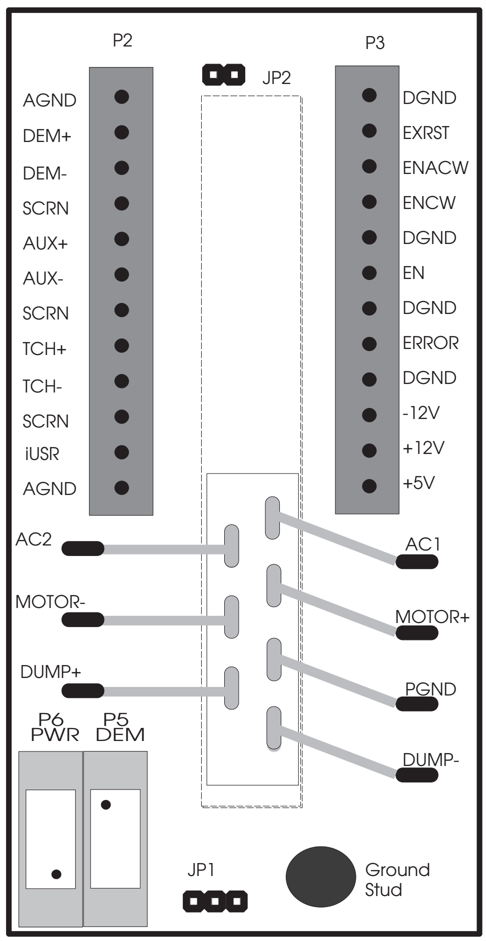
2.1 Connector Pin-out

	d	b	z
2	Demand +ve	Clockwise Enable	Master Enable
4	Demand -ve	Anti-clockwise Enable	GND
6	GND	Reset	GND
8	Tacho +ve	+5V	+5V
10	Tacho -ve	GND	GND
12	GND	Error Output	+12V
14	Aux +ve	Aux input -ve	-12V
16	GND	Current Monitor	GND
20			AC1
22	AC2		
24			Motor +ve
26	Motor -ve		
28			GND
30	Dump +ve		
32			Dump -ve

Figure 2.1: 31 way connector pin-out

2.2 Connector Layout - Single Amplifier Backplane

A single amplifier backplane is used to provide easy connection to EuroAmp/10. Screw connectors allow quick wiring directly to all low level signals. All high power connections are made via standard $^1/_4$" spade terminals.



JP1

Axis Y Selected

Axis X Selected

Note that fitting JP2 connects
ENable to the DEMand IDC connector

Ref:backplan

Figure 2.2: Single Amplifier Backplane

2.2.1 Amplifier connections

Name	Description
+5V	+5V power output
+12V	+12V power output
-12V	-12V power output
DGND	Digital ground
ERR	Error output
DGND	Digital ground
EN	Master enable input
ENCW	Enable clockwise input
ENACW	Enable anti-clockwise input
AGND	Analogue ground
DEM+	Demand positive input
DEM-	Demand negative input
SCRN	Cable screen
AUX+	Auxiliary positive input
AUX-	Auxiliary negative input
SCRN	Cable screen
TCH+	Tachometer positive input
TCH-	Tachometer negative input
SCRN	Cable screen
Spade Connections:	
AC-1 & 2	AC or DC power input
MOTOR+	Motor positive output
MOTOR-	Motor negative output
DUMP+	Dump resistor positive
DUMP-	Dump resistor negative
PGND	Power ground
IDC Connections	
P6 PWR	Connects direct to EuroSystem power inputs
P5 DEM	Connects direct to EuroSystem demand outputs

2.2.2 IDC Connectors

2.2.2.1 P5: DEM: Demand Inputs

```
         Error In  ■  1    2  ■  Error Out
     Cable Screen  ■  3    4  ■  Analogue Ground
  Demand_0 +ve In  ■  5    6  ■  Demand_0 +ve In
Demand_0 -ve (Agnd) ■ 7    8  ■  Demand_1 -ve (Agnd)
  Demand_1 +ve In  ■  9   10  ■  Demand_1 +ve In
```

Jumper, JP1, determines whether axis 0 or axis 1 is being addressed from EuroSystem.

2.2.2.2 P6: PWR: Power Outputs

```
Dgnd  ■  1    2  ■  Dgnd
Dgnd  ■  3    4  ■  Dgnd
 +5V  ■  5    6  ■  +5V
+12V  ■  7    8  ■  +12V
-12V  ■  9   10  ■  -12V
```

2.2.3 Earth Stud

This connection should be used as the main earth point for your controller. It should be connected to a low impedance earth star point within the system

2.3 Ancillary Power Outputs

In a two axis system, using EuroSystem, the controller can be powered from one of the amplifiers using the IDC connector. The power outputs from the second amplifier can be used externally if required. Parallel connection of the power supply outputs is not recommended.

The power connections for the system are brought out on the spade terminations. In order to make the system operate you need only connect the AC bus voltage, all other voltages are derived by the amplifier. However, it is most important that these power connections are hard wired to both amplifiers in a two axis system. In addition, all PGND connections must be hard wired together. Correct grounding is most important if your system is to operate properly.

3. Initial Set-up

3.1 Connecting Power

Pin-out:

Din Connector	Backplane	Description
AC1 (20)	spade	AC or DC power input
AC2 (22)	spade	AC or DC power input
PGND (28)	spade	Power ground

EuroAmp/10 contains an onboard rectifier and smoothing capacitors and will accept either AC or DC power input. Connections should be made to AC-1 and AC-2, polarity is not important.

> **PGND** must **be connected to the GND of your system to ensure that the amplifier is referenced to ground and will provide safe and reliable operation .**

An AC input voltage is rectified to produce a smooth DC bus to the output stage. The magnitude of the DC bus voltage is a function of the input voltage magnitude and type. A DC input voltage is not affected in terms of magnitude and passes 'straight through' to the power stage, whist an AC input voltage is subject to rectification and produces a DC bus voltage which is $\sqrt{2}$ times greater than the AC input voltage (depending upon the supply impedance).

If extra smoothing is required then further capacitors may be connected externally between DUMP+ and PGND.

3.2 Selecting a Transformer

If you are using an AC input then you must select a transformer which will match the motor and application requirements.

First, select the DC voltage required to drive your motor at the desired speed. This is achieved by calculating the back EMF of the motor when rotating and adding an additional headroom voltage which is required to overcome this back EMF and allow current to flow into the motor. The back EMF constant is a function of the motor windings and is defined as K_e in manufacturers data sheets. The headroom voltage will be a function of the resistance (R) of the motor windings, and the peak current (I_{pk}) passing through the motor.

Due to the PWM nature of the amplifier an allowance must also be made for the output duty cycle range of 10%-90%, noting that if the output is positive for 90% of the time then it is negative for 10 % resulting in a net positive duty cycle of 80% :- the absolute maximum output voltage will be V_{bus} x 0.8. A factor of ß ($^1/_{0.80}$) must be applied to the input voltage in order to achieve the desired output voltage from the system

[ ] = Units

DC bus voltage(V_{bus}) [V]	= (Back EMF [V] + Headroom Voltage [V]) x ß
Back EMF [V]	= (K_e [V/KRPM] x Max Speed [KRPM])
Headroom voltage [V]	= R [Ω] x I_{pk} [A]

The torque developed by the motor will be a function of the current I delivered to the motor. Torque is related to current by the torque constant K_t which will be defined in the motor manufactures data sheet. Both the peak current I_{pk} and the continuous current I_{cnt} must be calculated. These values determine the Headroom voltage and transformer VA respectively.

I_{pk} [A]	= peak torque [Nm] / Kt [Nm/A]
I_{cnt} [A]	= continuous torque [Nm] / Kt [Nm/A]

You may now select a transformer using the value calculated above.

The transformer VA rating is based upon normal operating conditions. During peak current demand, your transformer may show a slight drop in output voltage, depending upon the particular type of transformer used. For most applications this should be acceptable.

Transformer output volt (AC)	$= ß \times V_{bus} / \sqrt{2}$
Transformer VA rating	$= V_{bus} \times I_{cnt} \times \sqrt{2}$

Note:

The additional factor of √2 in the VA rating is required to allow for the non-unity form factor of the transformer current:- in a rectifier AC system, the peak charging current into the smoothing capacitors will be in the order of √2 greater than the average current, In practice, the larger the VA rating of your transformer, the better will be your servo performance.

Note:

Bus voltage V_{bus} has an operating range of +24V to +65V

Example:

You require a transformer to drive a motor at 3200 RPM with a continuous torque of 0.06Nm and a peak torque of 0.1 Nm.

K_e = 6.2 V/KRPM
K_t = 0.082 Nm/A
R = 0.5 Ω

I_{pk} = 0.1 / 0.082
I_{pk} = 1.22A

I_{cnt} = 0.06 / 0.082
I_{cnt} = 0.73A

DC bus voltage	= (6.2 x 3200/1000 + 1.22 x 0.5) x ß = 20.45 x 1/0.8 = 25.6V
Transformer Voltage	= 25.6 / √2 = 18.1V
Transformer VA	= 25.6 x 0.73 x √2 = 26.42VA

3.3 Operating Voltage Range

There is a strictly defined operating range for the DC bus and this must be observed for your amplifier to operate safely.

- DC Bus voltage range 24V <= V_{bus} <= 65V
- DC input voltage range 24V <= V_{in} <= 65V
- AC input voltage range 17V_{ac} <= V_{in} <= 46V_{ac}
- Tacho range ±50V

3.3.1 Under Voltage

Should the DC bus drop below 12V, an under-voltage condition will occur and the amplifier output stage will be shut down. When the voltage rises again the amplifier will be enabled again.

3.3.2 Protecting Against Over-voltage

Pin-out:

Din Connector	Backplane	Description
DUMP+ (30)	Spade	Dump resistor positive
DUMP- (32)	Spade	Dump resistor negative

An over-voltage condition is sensed by the amplifier and used to switch in a ballast (dump) resistor across the DC bus thus dissipating excess energy in the form of heat. There is a 33Ω dump resistor onboard EuroAmp/10 and it is capable of dissipating a continuous power of 4W. For greater power dissipation, an external power resistor must be connected across outputs DUMP+ and DUMP-. A metal clad 10Ω, 100W power resistor is recommended for typical hard reversal applications, however if this becomes unacceptably hot, then a higher rated resistor should be installed.

During power dumping, the full DC bus voltage will appear across the output pins DUMP+ and DUMP-, and as such any connecting wires must be safely insulated.

3.3.3 CAUTION !!

The purpose of the power dump is to dissipate energy during motor reversals or regeneration cycles. It is not intended for continuously dropping excessively high input voltages.

Should the DC bus voltage rise to 80V you will be in danger of destroying your amplifier.

3.4 Applying a Load

The amplifier has an onboard switched mode power supply which is used to power functions internal to the amplifier. It may also be used to provide power for ancillary components such as fans or encoders. This PSU requires no external minimum load.

3.5 Connecting a Demand Input

Pin-out:

Din Connector	**Backplane**	**Description**
DEMAND+ (d2)	P3:DEM+	Demand +ve input
DEMAND- (d4)	P3:DEM-	Demand -ve input
AGND (z10,d12)	P3:AGND	Analogue ground

EuroAmp/10 has a demand input which accepts an industry standard +/- 10V signal.

The input stage is differential and as such is capable of rejecting the common mode noise which is found in typical industrial environments where long cable runs may be used.

DEMAND- should be connected to analogue ground of your controlling equipment and DEMAND+ to the output demand of your controlling equipment. Connection should be made using 7/0.2 twisted wire pair.

If you are using EuroAmp/10 with the EuroSystem backplane, the demand signals are brought out through the IDC connector, P5:DEM. JP1 must be used to enable the axis as either X or Y as shown below:

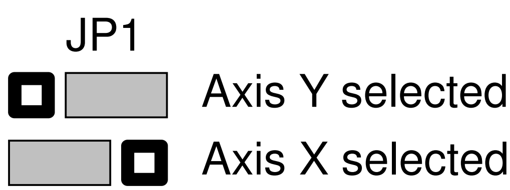


Figure (3.5) Selecting the axis.

3.6 External Digital Inputs

3.6.1 Master Enable

Pin-out:

Din Connector	**Backplane**	**Description**
ENABLE (z2)	P2:EN	Enable input
DGND (z4,z6)	P2:DGND	Digital ground

Enable is used to enable or disable the output power stage of your amplifier.

When enable is active, the amplifier will function normally and delivery full demand current to the motor.

When enable is inactive, all of the output transistors are turned off and zero current is delivered to the motor. The ancillary voltage outputs remain active at all times. The yellow indicator, DIS, is illuminated to indicate that the amplifier is not active.

The sense of the enable input is jumper selectable as either: enabled by grounding the input, with no connection or voltage causing disable (jumper JP1 inserted in the position nearer to the LEDs) or disabled by grounding the input, with no connection or voltage causing enable (with JP1 inserted nearer the potentiometers).

If you are using the EuroAmp/10 backplane with the EuroSystem backplane, jumper JP2 must be inserted if the IDC demand inputs are used. Only jumper JP5 must be connected on EuroSystem for use with EuroAmp/10 (see Error Output in the EuroSystem Reference Guide for further details).

3.6.1.1 Safety Note !!

Enable should not be used as the only means of removing power from the motor load. You are recommended to use external contactors to fully isolate your motor from the amplifier. This is particularly important when an operator may be required to enter a machine as part of its reload cycle

3.6.2 Directional Limits

The directional limit inputs are used to selectively disable the amplifier in a specific direction, this allows end of travel limits to respond more quickly. It also allows the use of joy-sticks of other direct user control to power off an end of travel switch under control. If not required these inputs can be disabled by linking solder jumpers SJ1 (for CW) and SJ2(for CCW).

3.6.3 Reset Input

The RESET input allows errors to be cleared without the need to switch off the amplifier.

The input is AC coupled to prevent a short circuit on this input overriding any error conditions

3.7 Error Output

Pin-out:

Din Connector	Backplane	Description
ERROR (b12)	P2:ERR	Error output
DGND (z4,z6)	P2:DGND	Digital ground

Error is an open-drain output which can be pulled-up externally by the user or internally to 12V by making SJ3.

The sense of the output can be either active low on an error condition (with SJ5 made), or active low during normal operation (with SJ4 made). SJ4 and SJ5 must not be made at the same time.

Conditions that will cause an error condition are:

- over-temperature
- extreme over-current

4. Amplifier Set-up

The follow diagrams show the physical layout of potentiometers, LEDs and jumpers on the EuroAmp/10:

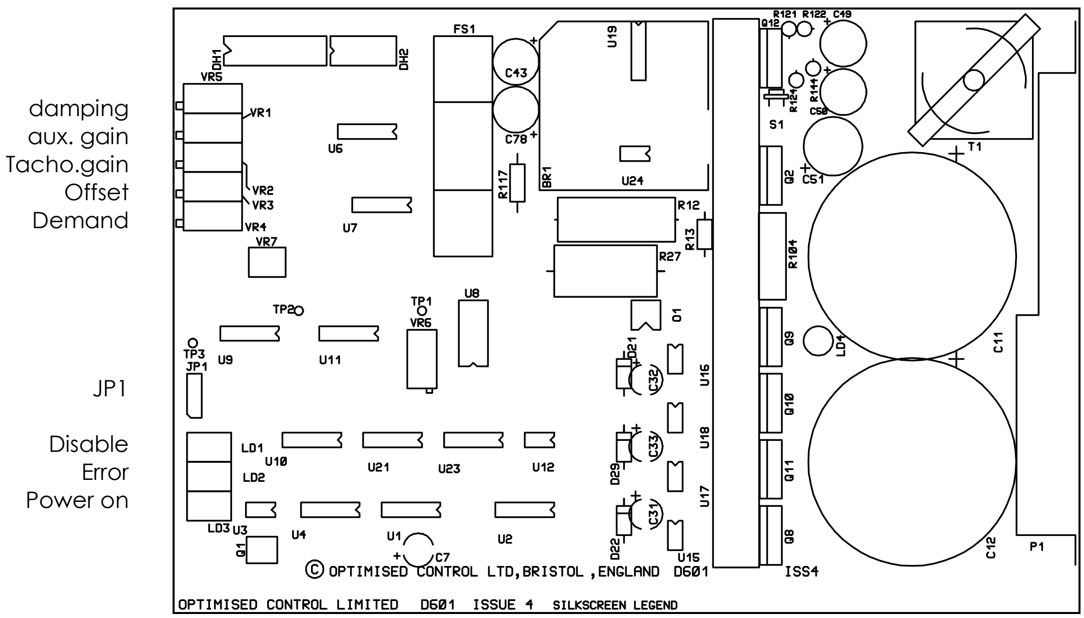


Figure 4.1 Top-side layout of EuroAmp/10

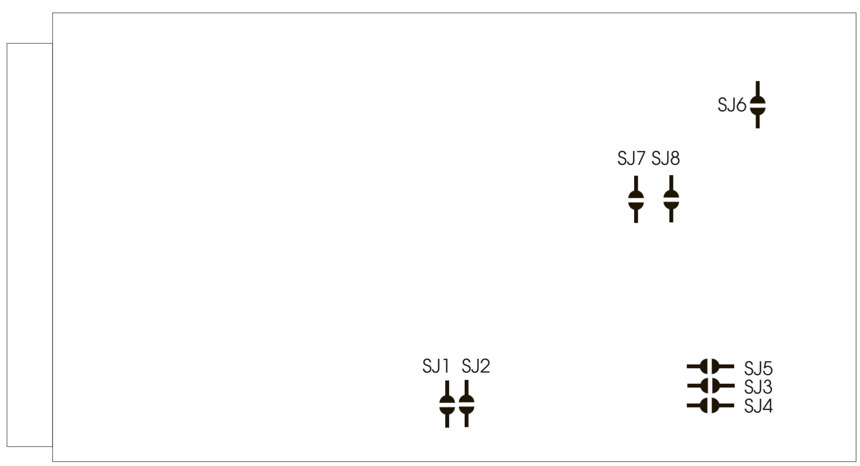


Figure 4.2: EuroAmp10 underside showing solder jumper location

4.1 Setting Maximum motor Current

It is important that you match the amplifier current to that of your motor if you are to achieve the full life from your motor. The peak current of your amplifier is factory set at 20A and this may be sustained until an over-temperature fault occurs. Remember that EuroAmp/10 is designed to operate at 10A continuously and that this corresponds to a demand input of +/- 5V. A demand of +/-10V corresponds to a current of +/-20A.

If the amplifier is configured for operation as a current (torque) amplifier then there are three methods available for limiting the current:-

Limit the maximum torque demand in software.

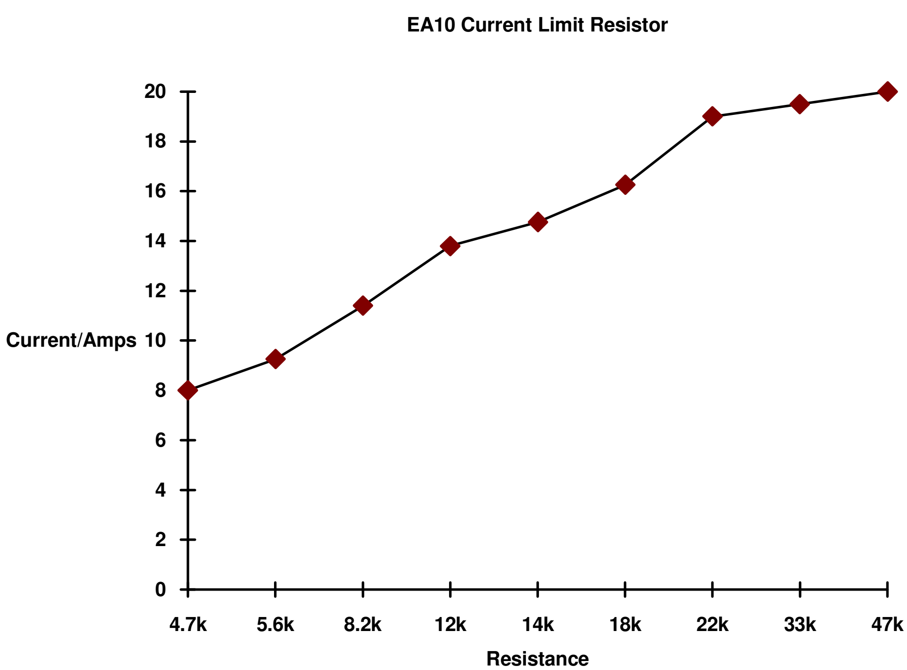
Limit the maximum torque demand by adjusting the demand potentiometer VR4 or by increasing R45 from 10k, doubling it will halve the peak demand.

The maximum current allowed is set by R94. This is done using a cycle by cycle technique. This resistor only sets the **maximum** current the amplifier can output, (even if the motor is short circuit) it has no effect on the gain of the amplifier. For example, if a factory set amplifier 10A/20A with 20A max. has R94 altered so that the maximum current is 10A. An input demand of 5V will still produce an output current of 10A, however, since the maximum current is set to 10A, any demand voltage above 5V will still only produce 10A.

If the amplifier is configured for velocity mode then only method 3 above applies.

If the maximum current is set at a level of 10A or less, the amplifier will be able to sustain this "peak" indefinitely.

The following graph shows the relationship between the value of resistor R94 and the maximum current the amplifier can output.



The graph will give you a value for resistor R94 to set the maximum current at any value you need. For example, if you wish to set the maximum current to 14A you can read from the graph that a value of 12kΩ would be suitable.

4.2 Current or Speed Control ?

The core of EuroAmp/10 is a current amplifier, or torque amplifier producing an output current to the motor which is proportional to the demand input voltage. A demand input of +10V represents an output current of +100% peak current and -10V, -100% of peak current. Typically a current amplifier will be required when an external controller is used to provide servo loop closure and calculate motor demand torque (current). If you are using EuroSystem to control your amplifier(s) then you would normally configure it as a current amplifier.

For simple velocity control applications Euroamp/10 may be configured to accept velocity feedback from one of two sources. The feedback signal is subtracted from the demand signal and the resulting error signal is used to control the current through the motor. In such applications, the demand input of +/-10V represents a velocity of +/- 100% of a maximum velocity which you set during tuning.

EuroAmp/10 can be configured either as a current amplifier *or* a speed controller but not both. In each case the connection of power, Demand, control signals, ballast and motor are the same. Specific connection and set-up information is given for both current control and velocity control in the following sections.

4.3 Compatibility of the amplifier and motor

Switching amplifiers rely upon the motor's armature inductance to smooth out the motor current. EA10 switches at approximately 25kHz. It is worth calculating the ripple current that will flow in the motor, the worst case occurs when the motor is at standstill and the duty cycle is 50%. If we ignore the armature resistance then the ripple current is:-

$\Delta I = (V_{bus} / L_{motor}) . \Delta t$

Consider a motor with a 4mH inductance operating on a 30V bus.

$\Delta I = (30/0.004). 20\mu s = 150mA.$

This is perfectly acceptable. If the ripple current is too high the motor will suffer excess heating and the amplifier's current control may be adversely affected, try to keep it under 500mA.

Some motors have notoriously low inductance, notable the printed type ('pancake motor'), and an external inductor must be connected in series with the motor.

5. Current Amplifier Configuration

EA10 is supplied configured as current amplifier unless the customer has specially requested velocity mode. To configure EuroAmp/10 as a current amplifier or torque amplifier the following set up procedure must be observed.

- Fit 10k resistor into position R52 of DH1.
- Fit link into position C17 of DH1.
- Rotate TACHO trimmer, VR2, fully anti-clockwise to set Tacho gain to zero.
- Rotate DAMPING trimmer, VR5, fully clockwise to set it to zero.
- Rotate GAIN trimmer, VR4, fully clockwise to set DC gain to normal.
- Set Max. current to suit motor, refer to Amplifier Set-up.

R45, R46 are factory fitted into DH1 with 10K0 resistors. These values should remain untouched for most applications, however the following sections describe their function.

Connect your motor, ensuring that the correct polarity is observed.

5.1 Operating a Current Amplifier

If you have followed **all** the proceeding steps then your amplifier is now ready for use as a current (torque) amplifier. The demand input is used to represent the level of DC current delivered to the load. The gain of the demand input stage is set by resistor R45 and trim pot VR4 (GAIN).

With VR4 (GAIN) rotated fully clockwise, and R45 set at 10K, an input signal of +10V delivers 100% of peak current, and -10V delivers -100% of peak current. Use VR4 (GAIN) to achieve the required input gain for the current circuit.

NOTE:

The GAIN (VR4) control does not set the peak current for the amplifier, its sets the gain of the demand input circuit. For safe operation of your motor the maximum current of the drive must be set by R94.

If your input demand signal is small in relation to ±10V, you may not be able to increase the gain sufficiently to achieve the desired output current. The maximum gain is determined by the value of resistor R45 which is factory set to 10KΩ. By reducing the value of R45 it is possible to increase the gain of the demand input to the desired level:- halving R45 will double the gain.

5.2 Current Offset

It may be necessary to adjust the offset of your amplifier to ensure that the voltage and current to the motor is zero when the demand current is set to zero.

With the amplifier powered on, the OFFSET trimmer, VR3, should be adjusted to give zero voltage across the motor. If you do not have a voltmeter available, then it may possible to adjust OFFSET until the motor rotates freely in both directions. Rotating OFFSET anti-clockwise increases the positive current to the motor.

5.3 Using AUXILIARY Input

An additional AUXILIARY input is available which may be used in conjunction with the DEMAND input to provide external feedback into the amplifier. When this is used, the current output from the amplifier is a function of both the DEMAND and AUXILIARY inputs, and their respective gains.

The gain of the Auxiliary input stage is set by resistor R44 and AUX trimmer, VR1. AUX may be used to reduce the gain from a maximum value which is set by the ratio of R44 to R52 found on DH1.

If your input signal is small in relation to ±10V you may not be able to increase the gain . The maximum gain is determined by the value of resistor R44 which is employed. By reducing the value of R44 it is possible to increase the gain of the demand input to the desired level - halving R44 will double the gain. R44 is found on DH1 pins 4 and 11.

The auxiliary input is differential and as such it may be used for negative or positive feedback.

6. Velocity Control

To configure EuroAmp/10 as a velocity controller you must first select the correct form of velocity feedback for your application.

Tacho feedback can provide a good general purpose velocity control scheme over the full speed range of your motor however it can prove expensive especially when used with smaller sizes of motors.

Armature feedback provides the cheapest form of velocity feedback and relies upon the back EMF of the motor to indicate the speed of the motor shaft. No additional transducer is required. This method is acceptable for general purpose application which can tolerate temperature and long term drift in motor speed.

6.1 6.1 Tacho Feedback

Pin-out:

Din Connector	Backplane	Description
TACH+ (d8)	P3:TCH+	Tacho input +ve
TACH- (d10)	P3:TCH-	Tacho input -ve

To configure EuroAmp/10 as a velocity controller for tacho feedback the following set up procedure must be observed. You are strongly advised to perform initial setting with the motor removed from the application. Final tuning may be performed 'in-circuit'.

- Rotate DAMPING trimmer, VR5, fully clockwise to set damping to minimum.
- Rotate GAIN trimmer, VR4, fully clockwise to set DC gain to normal.
- Rotate AUX trimmer, VR1, fully clockwise to set auxiliary gain to normal.
- Rotate TACHO trimmer, VR2, fully anti-clockwise to set Tacho gain to zero.
- Set Max. current to suit motor, refer to Amplifier Set-up.
- Connect your motor, ensuring that the correct polarity is observed.
- Connect your tacho to the TACHO inputs, ensuring that the correct polarity is observed.

Ensure that DH1 is fitted with velocity compensation components - these are factory supplied for typical motor characteristics. Appendix A describes the purpose of these components.

Apply power: with zero input demand, the motor shaft should be stationary. If motion is observed, then you should adjust the OFFSET trimmer VR3 to bring the motor to a halt. If the motor accelerates off uncontrollably, then it is probable that the tacho is connected with the wrong sense. Reverse the tacho connections *or* the motor connections to correct this problem. Reversing the polarity of both the tacho and motor will have *no* effect.

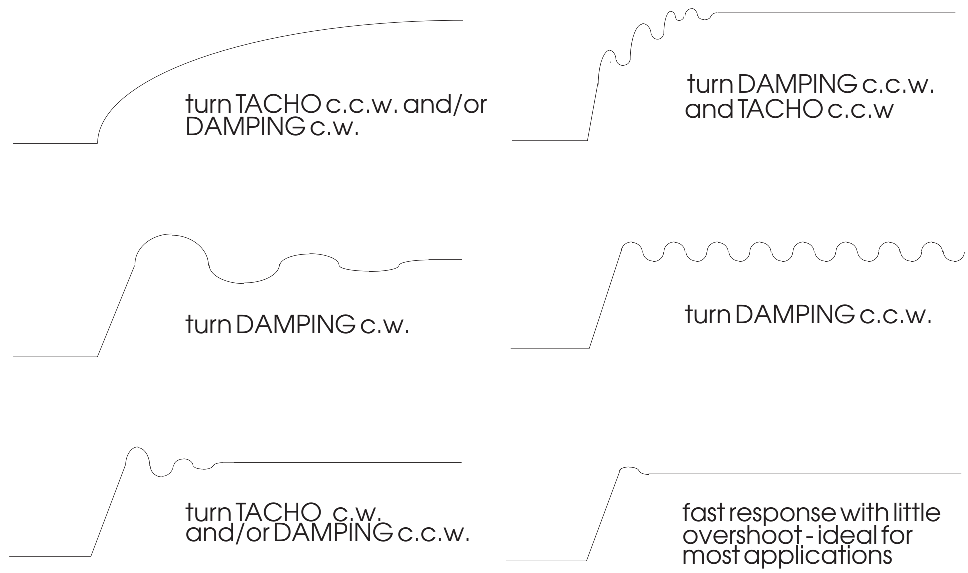
The amplifier may now be set up to achieve the optimum dynamic response. The motor should be placed in situ or if this is not possible then a representative load should be attached to the motor shaft

With the motor stationary, and zero demand input, rotate the DAMPING trimmer, VR5, ?-clockwise until the motor begins to oscillate, then turn back sufficiently to stop oscillation. If the mechanical time constant of your system is long then oscillation may not occur. This is not a problem. If the motor appears 'dead', then check the enable input.

6.1.1 Tacho Feedback: Setting the Step Response

To optimise the response of your amplifier and motor you will require an oscilloscope to observe the tacho voltage.

Apply a step input 0 to 10V and observe the response of the motor (tacho). Adjust the TACHO trimmer VR2 to achieve the least overshoot. This will affect the overall maximum speed however to not worry about this at this stage of the set-up procedure. If oscillation of the motor is evident then adjust the DAMPING trimmer to regain stability. By repeated adjustments to TACHO and DAMPING it should be possible to achieve an ideal step response as indicated below:



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With zero input demand re-adjust the offset trimmer if necessary.

Apply an input demand signal and adjust the GAIN trimmer to achieve the desired motor speed for that input value.

6.1.2 Using AUXILIARY Input With Tacho

Pin-out:

Din Connector	Backplane	Description
AUX+ (d14)	P3:AUX+	Auxiliary input +ve
AUX- (b14)	P3:AUX-	Auxiliary input -ve

The AUXILIARY input may be used in conjunction with the DEMAND input to provide external feedback into the amplifier. When this is used, the velocity of the motor is a function of both the DEMAND and AUXILIARY inputs, and the auxiliary gain set by the AUX trimmer, VR1.

The auxiliary input is differential and as such it may be used for negative or positive feedback.

6.2 Velocity Feedback - Armature (IR)

6.2.1 Armature Feedback Selection

Pin-out:

Din Connector	Backplane	Description
AUX+ (d14)	P3:AUX+	Auxiliary input +ve
AUX- (b14)	P3:AUX-	Auxiliary input -ve

If you are not using TACHO, then acceptable velocity control may be achieved by using the armature feedback EMF as an indication of motor speed. The armature voltage is sensed via the auxiliary (AUX) input stage and the AUX trimmer used to adjust the gain, consequently the auxiliary input is not free for use in this mode of operation.

With armature feedback, the feedback voltage is affected by both the motor velocity and the current passing through the motor windings. A current I will result in a voltage drop of I*R across the windings, and the resulting velocity of the motor is thus less than expected for a given input voltage. EuroAmp/10 provides IR compensation which operates by providing a positive feedback signal which is proportional to the motor current. The larger the current to the motor , the larger is the compensation feedback. The level of compensation required is a function of the motor resistance R, thus you must adjust the amplifier to match your motor.

With the amplifier configured for armature feedback, the TACHO trimmer may be used to adjust the compensation level. Rotating TACHO clockwise enhances the amount of compensation.

To configure EuroAmp/10 as a velocity controller for armature feedback the following set up procedure must be observed. You are strongly advised to perform initial setting with the motor removed form the application. Final tuning may be performed 'in-circuit'.

It is necessary to make solder jumpers SJ7 and SJ8 so that the motor voltage is connected to the AUX inputs, it is also necessary to make SJ6 so that the sensed current is connected to the tacho gain potentiometer. Consult figure 4.2 for the position of the solder jumpers. The AUX input must be enabled by a fitting a resistor, try 47k between pins 4 and 11 on DH1.

- Rotate GAIN trimmer, VR4, fully clockwise to set DC gain to normal.
- Rotate AUX trimmer, VR1, fully clockwise to set auxiliary gain to normal.
- Rotate TACH trimmer, VR2, fully anti-clockwise to set Tacho gain to zero.
- Ensure that no connection is made to either the auxiliary inputs or the tacho inputs.
- Set Max. current to suit motor, refer to Amplifier Set-up.
- Ensure that DH1 is fitted with velocity compensation components - these are factory supplied for typical motor characteristics. Appendix A describes the purpose of these components.
- Connect your motor, ensuring that the correct polarity is observed.

Apply power: with zero input demand, the motor shaft should be stationary. If motion is observed, then you should adjust the OFFSET trimmer to bring the motor to a halt.

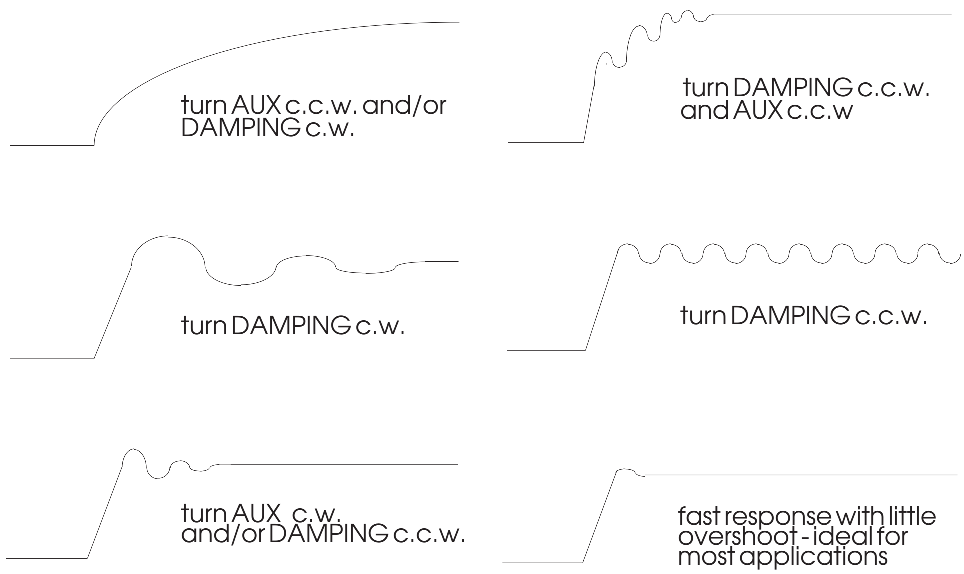
The amplifier may now be set up to achieve the optimum dynamic response. The motor should be placed in situ or if this is not possible then a representative load should be attached to the motor shaft

With the motor stationary, and zero demand input, rotate the DAMPING trimmer anti-clockwise until the motor begins to oscillate, then turn back sufficiently to stop oscillation. If the mechanical time constant of your system is long then oscillation may not occur. This is not a problem. If the motor appears 'dead', then check the enable input.

6.2.2 Armature Feedback: Setting the Step Response

To optimise the response of your amplifier and motor you will require an oscilloscope to observe the tacho voltage. If no tacho is available, tuning will have to be done 'by ear'.

Apply a step input 0 to 10V and observe the response of the motor (tacho). Adjust the AUX trimmer to achieve the least overshoot. This will affect the overall maximum speed however to not worry about this at this stage of the set-up procedure. If oscillation of the motor is evident then adjust the DAMPING trimmer to regain stability. By repeated adjustments to AUX and DAMPING it should be possible to achieve an ideal step response as indicated below



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With zero input demand re-adjust the offset trimmer if necessary.

Apply an input demand signal and adjust the GAIN trimmer to achieve the desired motor speed for that input value.

Compensating for IR Losses

With the motor rotating, apply a load to the shaft. The velocity of the shaft will reduce as power is dropped across the internal resistance of the motor. By adjusting AUX it should be possible to compensate for the internal voltage drop and regain the set speed of the motor. If the adjustment is insufficient to compensate completely, then it is possible to increase the gain further by reducing the value of R44 . Halving the value of R44 will increase the gain by a factor of two.

7. Using Ancillary Power Outputs

Pin-out:

Din Connector	Backplane	Description
+5V (z8)	P?:+5V	+5V power output
+12V (z12)	P?:+12V	+12V power output
-12V (z14)	P?:-12V	-12V power output
DGND (z4,z6)	P?:DGND	Digital ground

EuroAmp/10 contains a switched mode power supply which is used to generate three voltages for onboard control functions. The supply is has been rated at 6.2W so that you may also power an external controller and encoder if required. Thus your entire application may be powered from a single AC source.

- +5V @ 1A nominal
- +12V @ 50mA nominal
- -12V @ 50mA nominal

No external minimum load is required.

7.1 7.1 Power Outputs on IDC Connector

The power outputs are brought out onto the IDC connector P6:PWR and have the following pinout:

```
Dgnd  ■ 1   2  ■ Dgnd
Dgnd  ■ 3   4  ■ Dgnd
 +5V  ■ 5   6  ■ +5V
+12V  ■ 7   8  ■ +12V
-12V  ■ 9  10  ■ -12V
```

8. Specification

Parameter	Value	Conditions
AC supply voltage range	17V - 46V	
DC bus voltage range	24V - 65V	
Absolute maximum DC bus volts	75V	
Continuous output current	10A	25°C
Peak output current	20A	25°C
Fuse rating	20A fast	
Overtemp cut-off temperature	75°C approx.	
Power dump enable threshold	75V	
Continuous ballast rating	4W	
Ballast switch rating	20A	
(for external resistor)		
Demand input range	+/- 10V	
Demand input impedance	11 KΩ	
Demand input filter	1.4KHz	
Auxiliary input range	+/- 10V	
Auxiliary input impedance	11 KΩ	
Auxiliary input filter	1.4KHz	
Tacho input adjustable max. range	+/- 14V...90V	
Tacho input impedance	4.7 KΩ	
Tacho input filter cut-off	340Hz	
Switching frequency	25KHz	
Minimum load inductance	2mH	
(gives 1.3A ripple at 65V)		
Ancillary Output Voltage 1	+5V @ 1A	
Ancillary Output Voltage 2	+12V @ 50mA	
Ancillary Output Voltage 3	-12V @ 50mA	
Weight		
Dimensions card	160mm x 100mm	
Dimension total	175mm x 100mm x 54mm	

9. Appendix A: Velocity Loop Compensation

The forward DC gain of the velocity loop is determined by R52 and the respective input resistors R44, R45, R46 which are factory set to 10K. These resistors are located in DH1.

There are two important frequencies to consider within the velocity loop:

9.1 Mechanical/Pole Frequency

A feed-forward derivative is generally required to compensate for the mechanical pole of the system. This is achieved by introducing a capacitor C18 and resistor R53 series combination in parallel with R46. The pole frequency is determined by:

F_{vp} = 1/(C18 x R53)

Assuming a mechanical time constant of 4mS, values of C18 and R53 may be established.

Let:

R53 = 6K8
F_{vp} = 1500 rads/s
C18 = 0.1uF

The value of R46 will determine the forward DC gain of the velocity loop and this should be maintained at 10K to ensure a stiff system.

9.2 Damping Frequency

An integrator is provided by C17 and R52, with VR5, DAMPING, being used to modify the operating point of this filter. This filter provides a damping within the velocity loop and should be adjusted to suite the mechanics of the system . For most applications set C17 to 330nf and R52 to 56K. VR5 is a 100k potentiometer and as such gives a frequency adjustment ratio of 3:1.

F_{vr} = 1/(C420 x R35) rads/s
F_{vr} = 324 to 116 Hz

10. Appendix B: Indicator Lamps

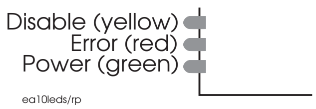

Figure 9.1: Indicator lamps at front bottom edge of board

There is also an LED situated between the two large capacitors by the connector, it illuminates when the dump circuit is dumping regenerative current into the dump resistor.

10.1 PWR - Power

The PWR indicator should be illuminated at all times when power is applied to the amplifier. During normal operation with no fault conditions and the amplifier enabled, this green lamp will be the only illuminated indicator.

10.2 DIS - Disable

The DIS indicator echoes the state of the ENABLE input to the amplifier. When ENABLE is inactive, the DIS indicator will be illuminated and the amplifier output stage will be disabled. When ENABLE is active the indicator will be extinguished and the amplifier will operate, provided that a fault condition does not exist.

10.3 ERR - Error

The red ERR indicator will illuminate if one of two events occur.

10.3.1 Over temperature

If the temperature of the heatsink becomes excessive, an overtemperature condition will occur. This is not a dangerous condition, however it does indicate that the amplifier has either insufficient ventilation or is being operated at high current for to long. Fan assisted cooling may be required for your application.

10.3.2 Extreme over current

Should a short circuit condition occurs, which cannot be detected by the normal current sensing circuit, the extreme over current circuit will operate if the current exceeds its threshold of 25-30A.

Should either of these faults occur, the output stage of the amplifier will be disabled. If an over temperature fault has occurred you will be unable to reset the amplifier until the heatsink has cooled sufficiently.

10.4 Conditions with no indication

10.4.1 Current limit

In normal operation overcurrent conditions are controlled on a cycle by cycle basis, and no visual indication of this is given. Some audible squealing may be detectable.

Note that the Current Monitor output is available to the user and indicates the load current with a gain of approximately 1.16 A/V.

10.4.2 Under voltage

If an under voltage condition arises the output stage of the amplifier is disabled with no indication. This condition normally only occurs on power up and down.

11. Appendix C: Trimmers & Component Header

Trimmer	Description
VR5: DAMPING	Dampen motor vibration
VR1: AUX	Auxiliary gain
VR2: TACHO	Tacho gain
VR3: OFFSET	Output voltage offset to motor
VR4: GAIN	Demand input gain

A summing amplifier is used to sum the signals from auxiliary, tacho, and demand input stages. The resulting signal represents the error demand, (the difference between demand and feedback signal), and is used as a demand into the current section of the amplifier block.

The gain of each input stage is set by both a fixed resistor and a trimmer. The fixed resistor is used to set the maximum gain of the associated stage, and the trimmer will allow you to adjust the gain from zero to this maximum value. R44, R45, R46 are used to set the maximum gains of auxiliary, demand and tacho inputs respectively. These are located in component header DH1 and are factory set to 10K. It may be necessary to change these values to suite your application, and you are referred to sections 5 and 6 for further information.

11.1 Component Headers

DH1:

Pin	Component	Factory value for velocity mode	Factory value for current mode	Description
1	R46	100k	∞	Sets max. tacho gain
2	C18	100nF	∞	Sets zero for tacho
3	R53	6k8	∞	Sets zero for tacho
4	R44	10k	∞	Sets max. auxiliary gain
5	R45	10k	10k	Sets max. demand gain
6	C17	330nF	0R	P+I terms on overall feedback
7	R52	1k	10k	P+I terms on overall feedback

Refer to section 9 for more details on these components. R44 must be fitted if the amplifier is operated in armature feedback mode.

DH2:

Pin	Factory value	Component	Description
1	4n7	C21	Current control
2	220pF	C20	Current control
3	10k	R64	Current control
4	47k	R94	Sets current limit