STUDY AND OPERATION OF DC SPEED / POSSITION CONTROL SETUP

Step 1. (Page 1 to 4)

Study the description of the equipment.

Step 2. (Page 5 to 9)

A. Speed control of a DC motor.
B. Experimentally find the Techo-generator Constant to measure the speed of the motor indirectly.

Step3 (Page 10 to 19)

A. Run the DC motor at no-load condition at 1500rpm and 2000 rpm. Then apply load using magnetic breaking arrangement. Note speed / breaking position under both open-loop and close – loop conditions. (Page 10 to 15)
B. To study the pre-amplifier characteristics. (Page 16 & 17)
C. Perform the dc position control experiment given in page no 18 and 19

PRELIMINARY PROCEDURE

Attach Operational Amplifier Unit 150A, Attenuator Unit 150B, Pre-Amp Unit 150C, Servo Amplifier 150D, Power Unit 150E, Motor Unit 150F and Input and Output Potentiometers 150H and 150K to the Baseplate by means of their magnetic feet.

1. Connect the plug of the Servo Amplifier to the Power Supply 8 way socket.
2. Connect the plug of the Motor Unit to the Servo Amplifier 8 way socket.
3. Connect the Power Supply to the mains supply line. DO NOT switch on yet.

DISCUSSION AND EXPERIMENTAL PROCEDURE

So that you can become familiar with the kit before you start the assignments, examine each unit as it is described and then connect some of them together to see how the motor runs and its speed varies; the Practical in this Assignment describes how this is done.

Power Supply Unit 150E

This unit supplies a 24V d.c 2A unregulated supply to the motor through an 8-way connector to the Servo Amplifier, as it is this unit that controls the motor.

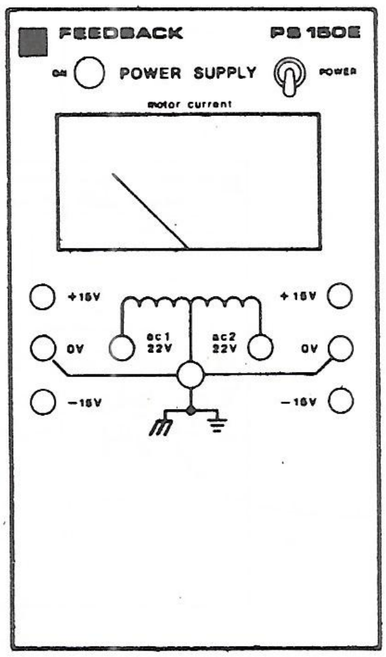


Fig 1.1

On the front panel there are two sets of 4mm sockets to provide ±15V, stabilised d.c supplies to operate the smaller amplifiers and provide reference voltages.

In the assignment practical work, the power supply will be represented as in fig 1.1.

To simplify the patching diagrams the 8-way connection from150E to the Servo Amplifier 150D is not shown.

The a.c outputs are used in the later Assignments only.

Motor Unit 150F

This unit is made up of three parts.

A d.c series-wound split-field motor which has an extended shaft, and onto which can be fixed the magnetic brake or inertia disc.

Integral in the unit is a d.c tacho-generator with output on the top of the unit.

For control experiments, there is a low-speed shaft driven by a 30:1 reduction gearbox. A special push-on coupling can link the output potentiometer to this shaft.

Power is obtained from the Servo Amplifier by an 8-way socket; this connection is not shown on patching diagrams.

Fig 1.2 gives the diagram for the tacho-generator connections.

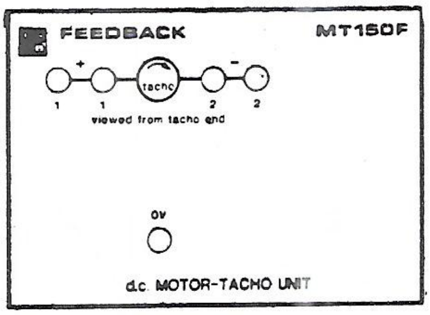


Fig 1.2

Servo Amplifier 150D

Contained in this unit are the transistors which drive the motor in either direction.

Provision is also made on the front panel for patching the armature for different modes of control.

To avoid overloading the motor, there is a motor current meter with a 2A overload indication and protection.

Fig 1.3 shows the layout.

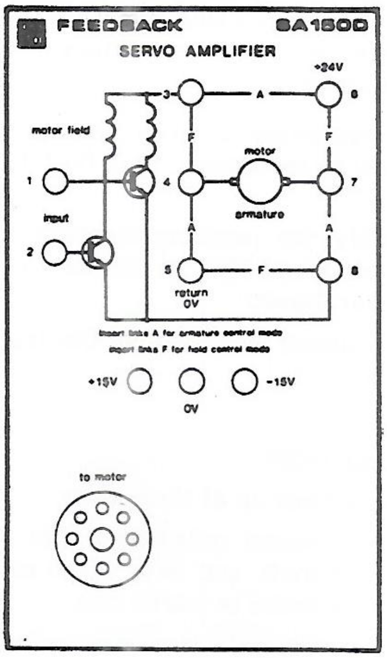


Fig 1.3

Attenuator Unit 150B

This unit contains two variable 10kΩ potentiometers. The proportion of the resistance being selected is indicated by a dial graduated from 0 to 10.

The unit can either provide a reference voltage when connected to a d.c source or be used as a gain control when connected to the output of an amplifier.

Fig 1.4 shows the layout.

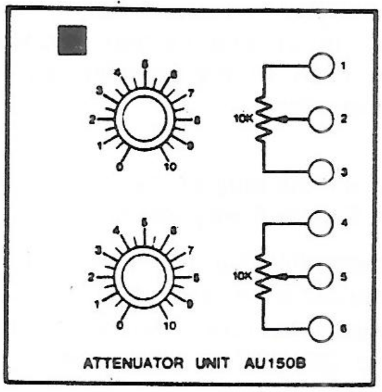


Fig 1.4

Practical – To Connect up the Motor

You are now acquainted with sufficient units to be able to connect up the motor. The motor direction depends upon which of the two field coils is energised, and the speed upon the amount of drive voltage applied to the inputs of SA150D. In this Practical we shall use one direction only, and vary the drive using one of the attenuators in AU150B.

Set up the circuit of fig 1.5, in which the armature links are patched for the armature-control mode.

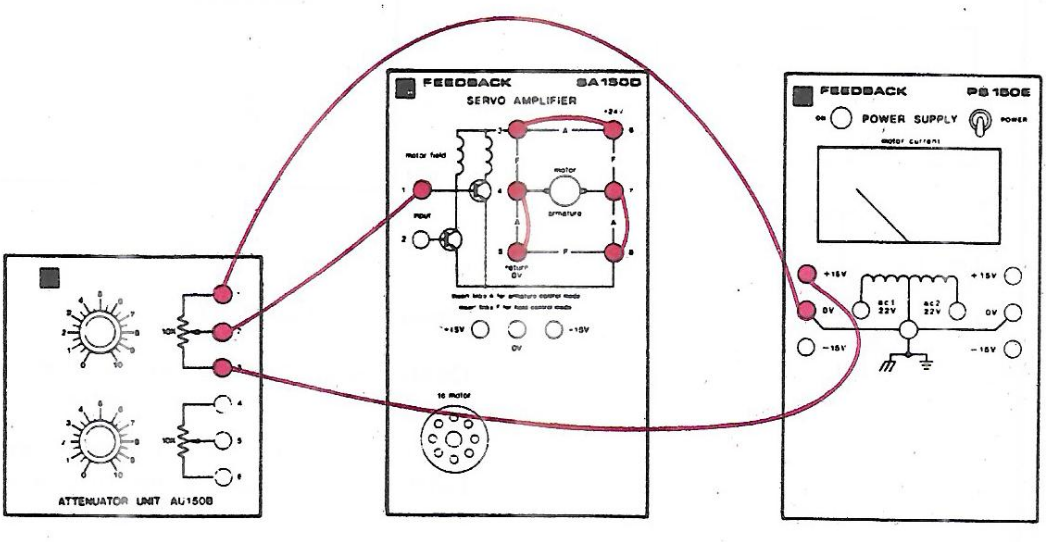


Fig 1.5

Switch on and turn the potentiometer knob; this will start the motor rotating. Do not race the motor.

For some reasonable speed, use the voltmeter to measure firstly, the amplifier input voltage relative to COM and secondly, the tachogenerator voltage between 1 and 2 on MT150F. The ratio $\frac{\text{TACHO-GEN VOLTS}}{\text{INPUT VOLTS}}$ represents the 'speed-constant' or 'speed-gain' of the motor-amplifier, a quantity of importance in determining servo performance.

Input & Output Potentiometers 150H and 150K

These are rotary potentiometers, used in experiments on position control. The 150H input potentiometer has $\pm 150^{\circ}$ of motion whilst the 150K output potentiometer has no mechanical stops and so cannot be damaged by continuous rotation.

The input potentiometer is used to set up a reference voltage and the output potentiometer is connected to the motor low-speed shaft by using the push-on coupling.

Fig 1.6 gives the circuit diagrams for these units.

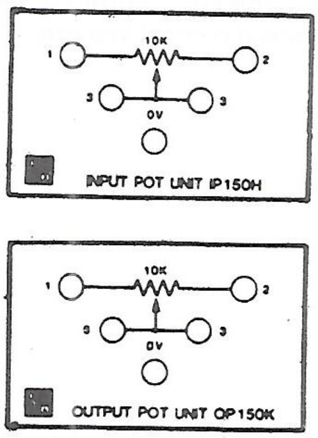


Fig 1.6

Pre-Amplifier 150C

This provides the correct signals to drive the servo amplifiers in SA150D.

The two inputs are effectively summed, allowing two signals to be applied e.g a reference voltage and the tacho-generator voltage.

A positive signal applied to either input causes the upper output (3) to go positive, the other output (4) staying near zero. A negative input causes the lower output (4) to go positive, the upper one staying near zero. Thus bidirectional motor drive is obtained when these outputs are linked to the SA150D inputs.

A toggle switch allows use with either of two internal compensation networks or in the 'normal' condition using neither.

Fig 1.7 gives the layout.

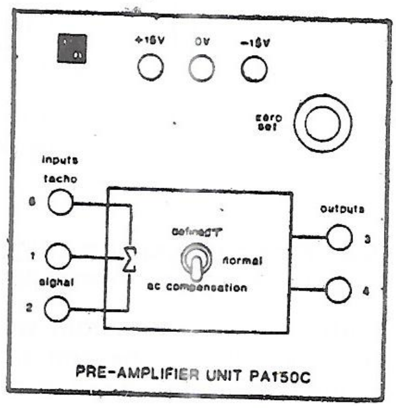


Fig 1.7

Operational Amplifier 150A

This provides inverting voltage gain and a means of summing two or more signals, as well as facilities for introducing compensation networks.

Fig 1.8 gives the layout,

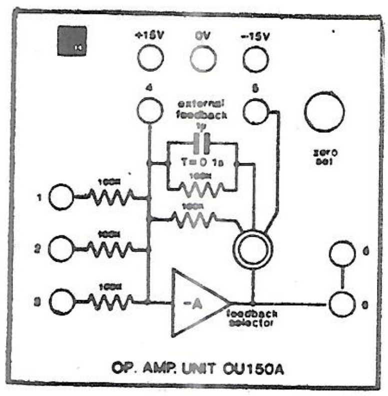


Fig 1.8

Load Unit 150L

An aluminium disc can be mounted on the motor shaft and when rotated between the poles of the magnet of the load unit, the eddy currents generated have the effect of a brake. The strength of the magnetic brake can be controlled by the position of the magnet. The circuit notes show the torque for the different positions at 1000 rev/min while for other speeds the torque will be proportional.

A chromium-plated brass disc can also be mounted on the shaft to increase the inertia of the motor.

Fig 1.9 shows the symbols used for the magnetic brake and inertia disc.

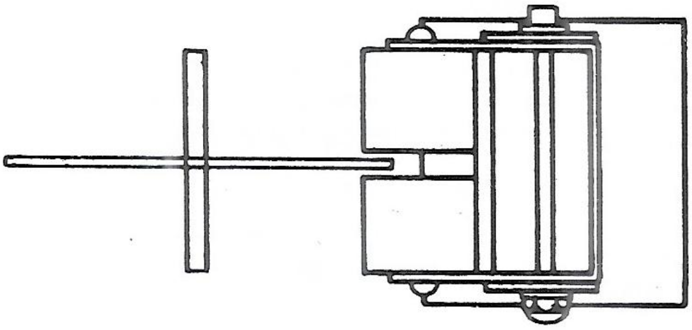


Fig 1.9(a) Load unit Magnetic brake

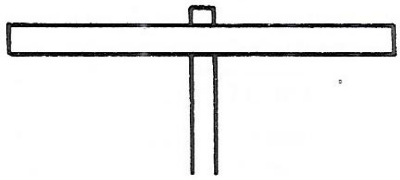


Fig 1.9(b) Load unit Inertia disc

PRACTICAL CONSIDERATIONS & APPLICATIONS

A lift comes to a smooth stop after shooting past many floors; the arm of a magnetic disc recorder smoothly stops at the correct track after taking milliseconds to reach it; missiles can be fired so that astronauts can land on the moon; the engines of a jet aircraft can be kept in synchronisation with each other. On these and on so many applications through every branch of industry, commerce and transport, the science of control engineering is used to ensure that what actually occurs does so smoothly, precisely and speedily.

Control engineering is an exciting technology whose principles and skill derive from mechanical, electrical and electronic engineering. In the following Assignments you will see how using the principles of automatic control can be applied to position and speed control systems.

PRELIMINARY PROCEDURE

1. Attach the Attenuator Unit 150B, Servo Amplifier 150D, Power Supply 150E, to the Baseplate by means of the magnetic fixings.

2. Fit the eddy-current brake disc to the motor shaft, using the split collet fixture provided with the 150L load unit. Ensure that the load unit can be fully engaged without fouling either the motor mount or the eddy-current disc.

3. Now attach the Motor Unit to the Baseplate by means of the magnetic fixings and fix the plug into the Servo Amplifier Unit.

4. Attach the Load Unit magnetic brake to the Baseplate by means of the magnetic fixings and position it, so that when the cursor is on position 10 the eddy current disc lies mid-way in the gap with its edge flush with the back of the magnet.

5. Fix the plug from the Servo Amplifier into the Power Supply Unit.

6. Connect the Power Supply to the mains supply line, DO NOT switch on yet.

DISCUSSION AND EXPERIMENTAL PROCEDURE

In later assignments we are going to show how an electric motor can be used in position and speed control systems.

This assignment will illustrate the characteristics of the motor used in this kit and show how it can be controlled by the Servo Amplifier.

The motor has a split field winding, with current flow in each part of the coil being controlled by a transistor. This means that the direction of rotation can be reversed, with Input 1 on the SA150D making the motor rotate in one direction and Input 2 in the other direction, as in fig 3.1.

As the motor accelerates the armature generates an increasing 'back-emf' V_a tending to oppose the applied voltage V_{in}. The armature current is thus roughly proportional to $(V_{in} - V_a)$. If the speed drops (due to loading) V_a reduces, the current increases and thus so does the motor torque. This tends to oppose the speed drop. This mode of control is called 'armature-control' and gives a speed proportional to V_{in}, as in fig 3.2.

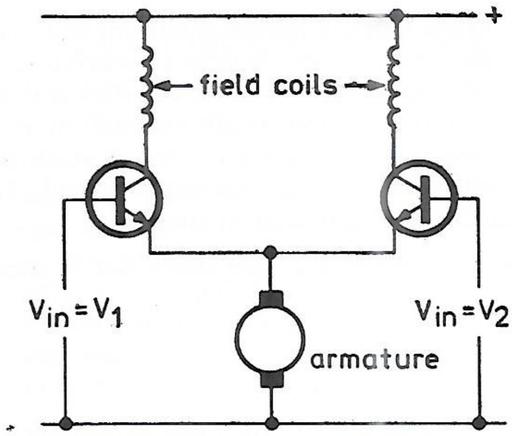


Fig 3.1 Armature control

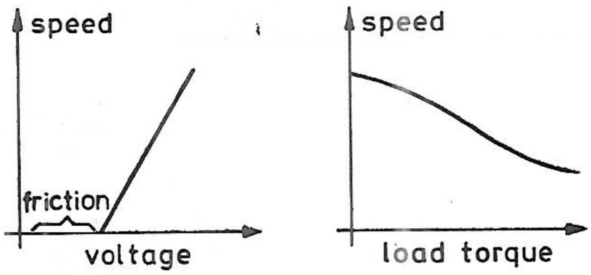


Fig 3.2

Due to brush friction, a certain minimum input signal is needed to start the motor rotating.

Fig 3.2 shows how the speed varies with load torque.

The connections on the Servo Amplifier also allow the armature to be connected in the collector circuits of the transistors, as in fig 3.3 and this configuration will be referred to as 'field control' from now on. In this case the back emf will have much less effect on the motor current.

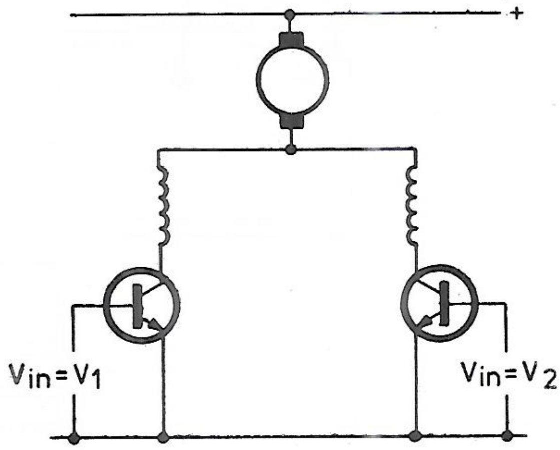


Fig 3.3 Field control

This means that the transistor current and therefore the motor current is largely determined by the input signal V_{in}. Fig 3.4 shows how with the motor unloaded, any small increase in input above the minimum value needed to start rotation will cause a large increase in speed. This makes the motor difficult to control.

Under load there is a very sharp fall in speed.

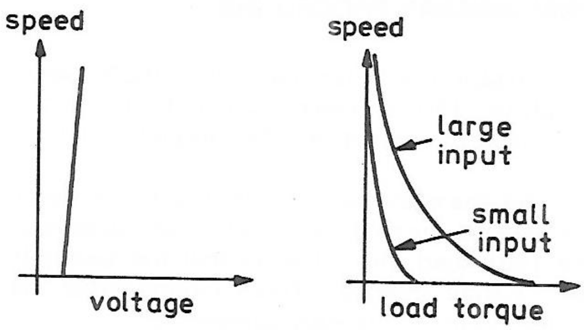


Fig 3.4

The first experiment will be to obtain the characteristics of the motor connected for armature control.

Connect as in fig 3.5.

Practical 3.1 Armature Control

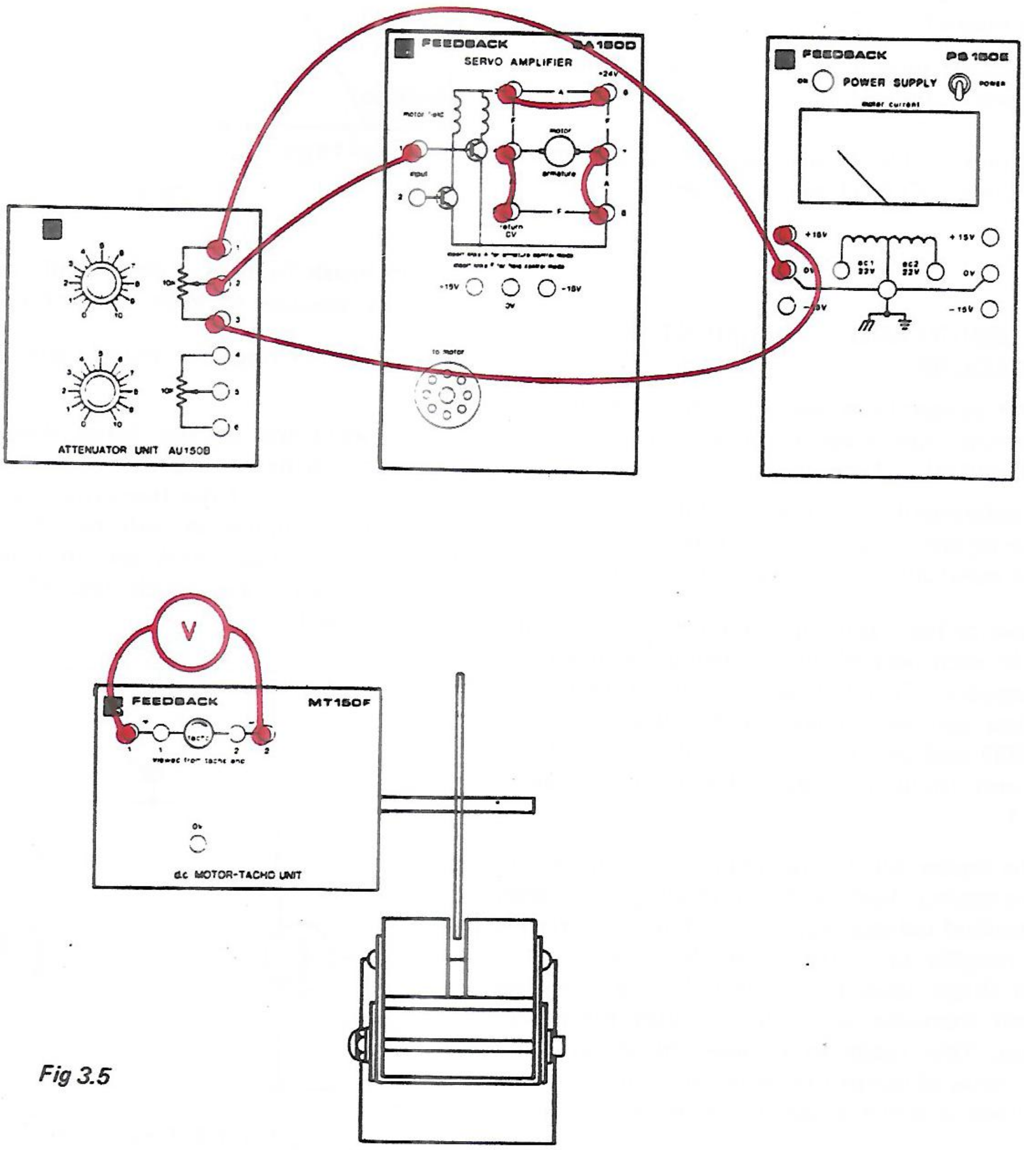


Fig 3.5

In connecting up, the 'A' sockets on the Servo Amplifier indicate that these should be linked for armature control.

By using one of the potentiometers on the Attenuator Unit, it is possible to obtain a variable signal input V_{in}.

The kit provides a tacho-generator coupled to the motor. To obtain values for speed, it will be necessary to calibrate this generator by finding the factor Kg, which is the volts generated per thousand rev/min of motor shaft.
Connect the voltmeter across the tacho outputs and switch on the power.

Set the magnetic brake to the unloaded position and turn the slider on the potentiometer till there is a reading of 1V on the voltmeter. Switch on the stop clock and count 20 turns of the geared 30:1 low speed shaft. Tabulate your result as in fig 3.6.

E3.1 Convert the readings in fig 3.6 to rev/min.

Tachogenerator volts	No of rotations	Time in seconds	Speed in rev/min

Fig 3.6

Repeat this reading with a 2V generator output. Then repeat for 3V, 4V and 5V but now count 40 turns. To obtain an accurate set of values repeat your reading, mean the results.

E3.2 Plot a graph of your results, as in fig 3.2, of Speed against Tachogenerator volts.

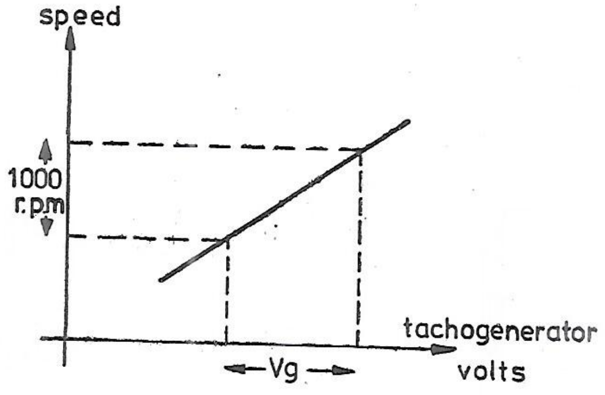


Fig 3.7

The calibration factor Kg = Vg/N rev/min. It should be about 2.5V to 3.0V per 1000 rev/min.

Now to find the slope of the speed/input volts curve without a load.

Reduce the input voltage till the motor is just turning then measure with your voltmeter the voltages between common and potentiometer slider and the tacho-generator outputs. Then tabulate as in fig 3.8. Increase the input voltage in one-volt steps, take readings of the input voltage and tacho-generator voltage till you estimate the motor is revolving at 5000rev/min.

E3.3. Plot the input voltages against speed, your results should be as in fig 3.2.

V_{in} volts	V_g volts	speed rev/min

Fig 3.8

E3.4 Calculate the slope (input volts per thousand rev/min).

To measure the torque/speed characteristics, fix the brake so that it passes over the disc smoothly while the motor is running.

Then set the brake at position 10 with the ammeter on the Servo Amplifier not exceeding 2 amp; note the value of the input voltage. Take tachogenerator readings over the range of the brake down to zero position, tabulating your results as in fig 3.8.

brake position	V_g volts	speed rev/min

Fig 3.9

Now reset the brake back to maximum position and reduce the signal input voltage so that the motor is slowly rotating. Note the actual value of the input voltage.

Take readings over the brake range tabulating the further results as in fig 3.9.

E3.5 Plot the two sets of results, as in fig 3.2, of Speed against Torque (brake position) for the two input voltage values.

For the second part of the assignment, reconnect the Servo Amplifier for field control, as in fig 3.10

Practical 3.2 To obtain field control characteristics

Set the motor into an unloaded position by swinging the magnetic brake clear of the disc.

Gradually increase the input voltage by turning the Attenuator Unit potentiometer. Initially the motor will not turn, because it has not enough torque to overcome the brush friction.

Since with field control the back emf does not affect the bias on the transistor the motor can accelerate to a very high speed. Do not allow it to speed over 5000 rev/min. (Observe the voltage on the voltmeter connected to the tachogenerator outputs).

Set the magnetic brake to its maximum and increase the signal input till the internal limiter reads 2A, note the input voltage value.

Traverse the range of brake positions, noting the values as in fig 3.9.

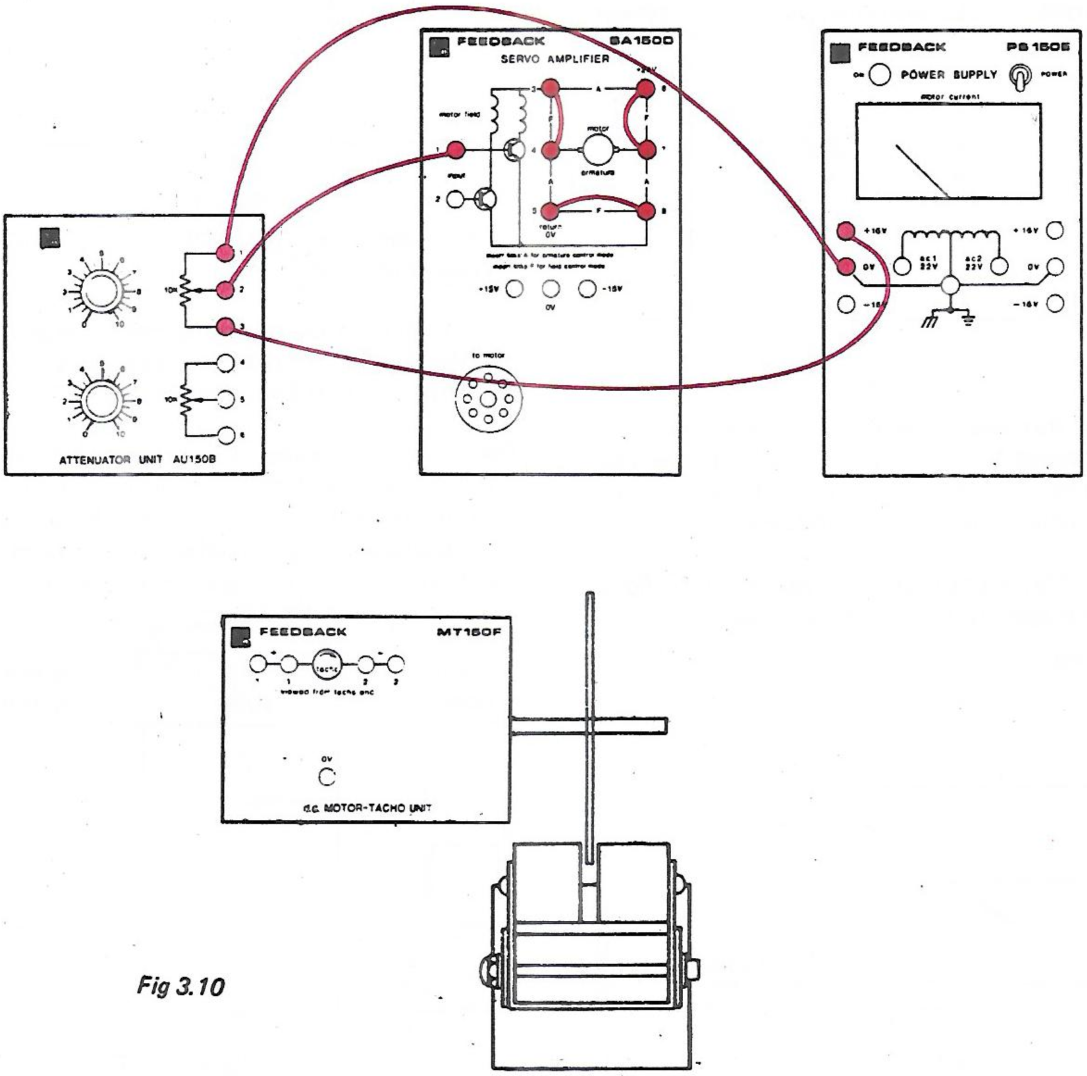


Fig 3.10

Stop recording at 5000 rev/min; this will be between positions 1 and 2 on the potentiometer. Reset the brake to position 10 and reduce the input voltage till the motor is slowly rotating. Take readings once more for the range of brake positions to a speed of 5000 rev/min noting the values as in fig 3.9.

E3.6 Plot graphs of your two sets of results as in fig 3.4.

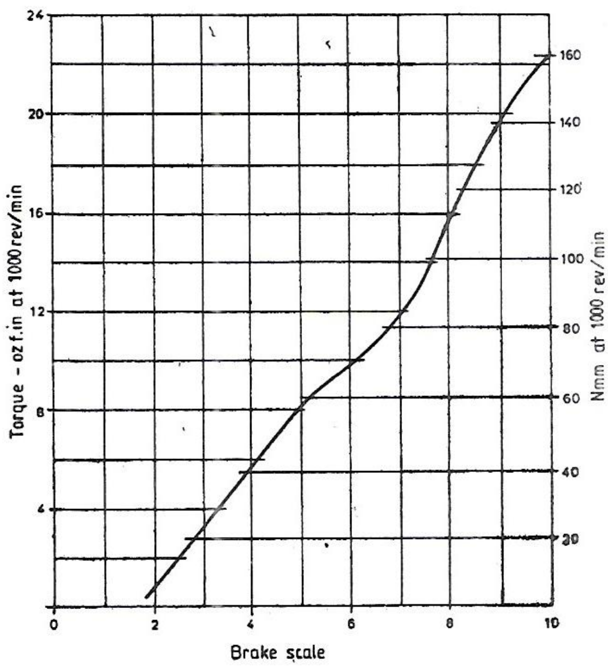


Fig 3.11 Approx brake characteristics at 1000rev/min (for other speeds, torque proportional to speed)

Fig 3.11 shows the approximate brake position/g.cm characteristics of the motor at 1000 rev/min. For other speeds, the torque will be proportional to the speed.

PRACTICAL CONSIDERATIONS & APPLICATIONS

The motor in MS150 is always connected so as to pass the same current through both field and armature. However, the two types of connection do give different characteristics, as you will have discovered.

Connected for field control the machine has a high starting torque with poor speed regulation, so that if unloaded the speed will become dangerously high. In this it resembles a normal series motor.

With armature control connection the negative feedback of the back emf will oppose the input signal and so tend to maintain a steady motor current; this results in a more constant speed over the torque range. As a result the torque/speed curve becomes more similar to that produced by a shunt wound motor. The gain for this connection is very much lower than if the motor is connected for field control.

The armature-controlled shunt-wound motor is extensively used in control systems and when the armature control is provided by a d.c generator, becomes the Ward-Leonard connection.

PRELIMINARY PROCEDURE

In Practical 7.1:

1. Attach the Operational Amplifier Unit 150A, Attenuator Unit 150B, Servo Amplifier 150D, Power Supply 150E and Motor Unit to the Baseplate by means of the magnetic fixings.

2. Connect the plug of the Servo Amplifier to the Power Supply.

3. Connect the plug of the Motor Unit to the Servo Amplifier.

4. Connect the Power Supply to the mains supply line. DO NOT switch on yet.

DISCUSSION AND EXPERIMENTAL PROCEDURE

Assignments 5 and 6 showed how simple open-loop position control systems could be constructed using the kit. In this assignment, we are going to deal in the same way with speed control.

Referring back to Assignment 3 on motor characteristics, you will see that you drew a curve of the signal inputs into the Servo Amplifier against speed. This means that without any load you can set the motor to run at a specified speed by determining the value of the input signal.

Q7.1 Can you say what sort of speed control system this was in Assignment 3?

Q7.2 Looking now at the torque/speed graphs in Assignment 3, say what will happen if a load is placed on the motor shaft and is then varied.

With an open-loop system the results showed that there can be reasonable speed control when operating without or with a fixed load but the system would be very unsuitable where the load was varying.

In this assignment we are going to show the improvement that can result from closing the loop and using feedback. That is, the actual speed will be compared with the required speed. This produces an error signal to actuate the Servo Amplifier output so that the motor maintains a more constant speed.

As a first experiment we will simply feed back a signal proportional to the speed, using the Tachogenerator. We then compare it with a reference signal of opposite polarity, so that the sum will produce an input signal into the Servo Amplifier of the required value. As comparator, we will use an Operational Amplifier.

Set up as in fig 7.1 and switch on power.

Practical 7.1 Simple closed loop speed control system

Connect the Servo Amplifier for armature control.

The field coil driving transistors on the Servo Amplifier require positive inputs, so that a negative reference plus a positive tacho voltage when summed and inverted in the Operational Amplifier will produce a positive output, the error voltage V_e.

Q7.3 Explain why the Tacho voltage has to be less than the Reference voltage.

Connect the potentiometer slider to an input of the Operational Amplifier. Before connecting the Tacho Generator to the input of the Operational Amplifier, turn up the slider on the potentiometer so that the motor revolves and on your voltmeter determine which is the Tacho's positive output. The correct side is then connected to the Operational Amplifier input and the other side to 0V.

Reset the reference voltage to zero and then gradually increase the reference voltage so that you can take readings over the motor speed range of up to 5000rev/min for the Reference, Tacho and error voltages.

Record as in fig 7.2 using the tacho calibration of Assignment 3 to calculate the speed.

E7.1 Plot the Error voltage against Speed, for the data recorded in fig 7.2.

Compare the Error/Speed results with those you obtained in Assignment 3 Motor characteristics, for match.

Q7.4 What would happen if you reversed the Tacho-generator connections to the Operational Amplifier and what sort of feedback would you call it?

To find out the effect of load on speed we can use the magnetic brake as a load. The change in speed for a change in load will give us the regulation.

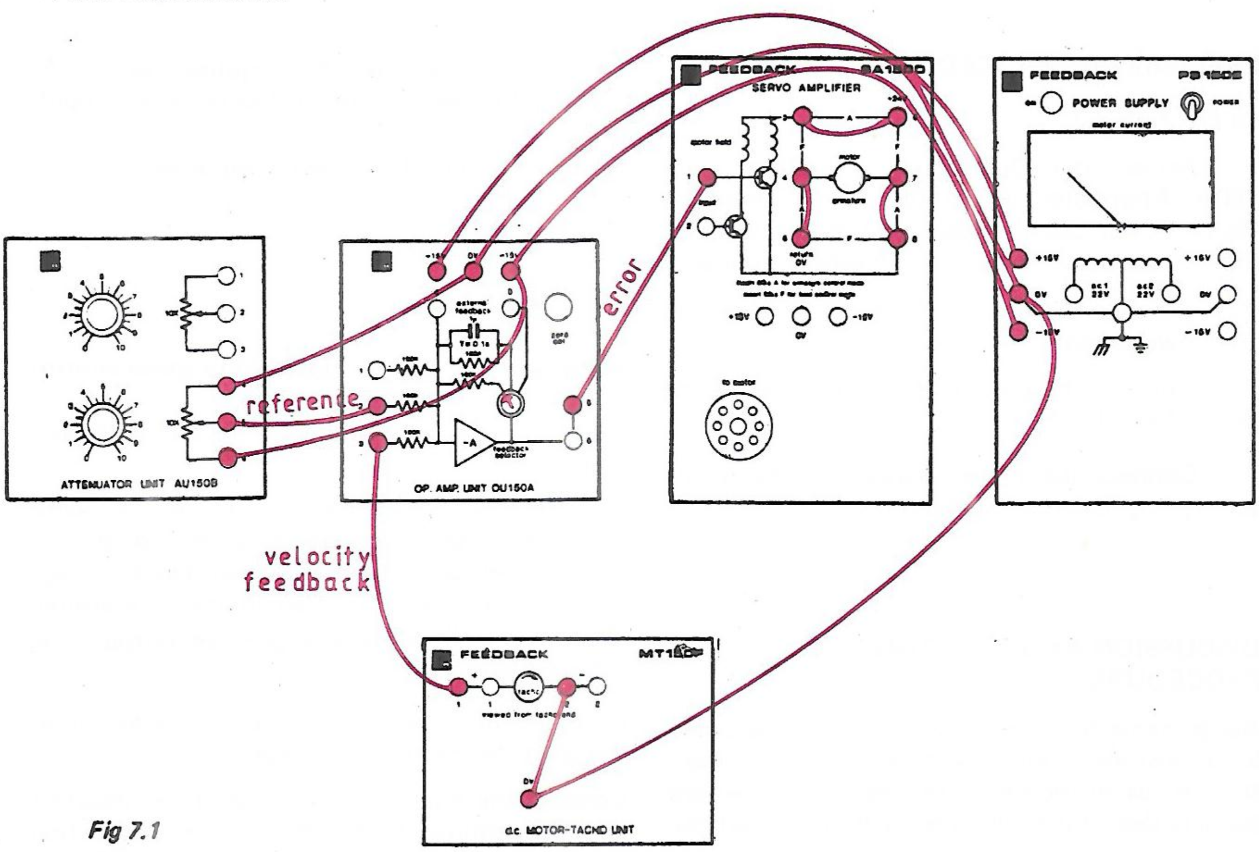


Fig 7.1

reference voltage	tachogenerator voltage	error voltage	speed rev/min

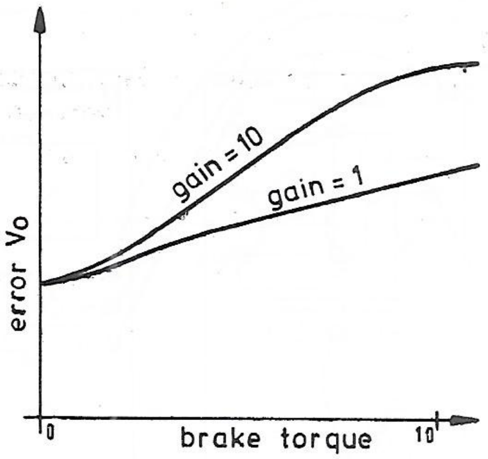
Fig 7.2

Fit the eddy-current brake disc to the motor shaft, using the split collet fixture provided with the 150L load unit. Ensure that the load unit can be fully engaged without fouling either the motor mount or the eddy-current disc.

The second part of the assignment is concerned to show how an increase in the forward path gain will cause a given fall in speed to cause a larger increase in the value of the error V_o, so that for any change of load the speed drop or 'droop' will decrease with increasing gain as in fig 7.3.

For a gain control we can use the circuit of fig 7.4, which was shown in Assignment 2 to have a gain of $-\frac{1}{a}$.

So set up as in fig 7.5. (see overleaf)



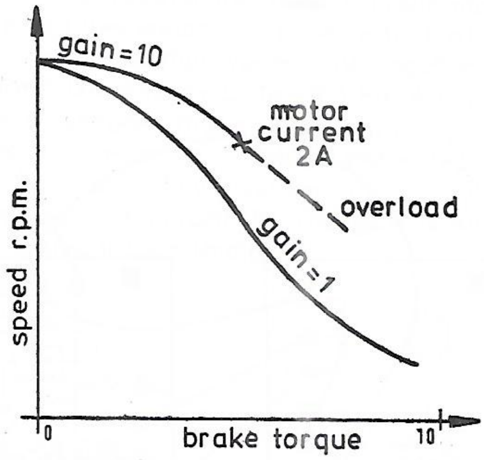


Fig 7.3

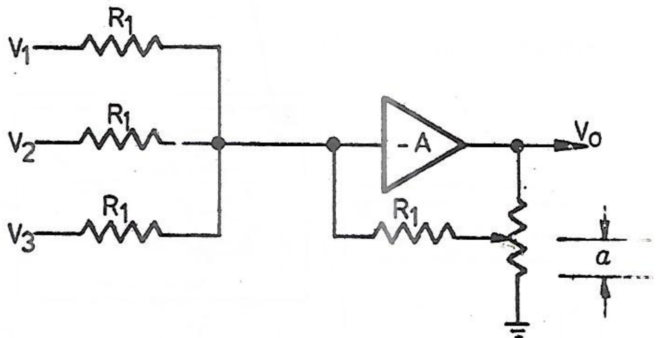


Fig 7.4

Practical 7.2 To show effect of gain on speed change for load change.

The apparatus should be set up as for Practical 7.1 On the Magnetic Brake swing the magnets clear.

Move the feedback selector switch on the Operational Amplifier to the external feedback position.

Initially set the gain to unity, that is to position 10 and adjust the reference volts till the motor runs at 1000rev/min. Then take readings of the Reference voltage, Servo Input error voltage V_e and the Tacho voltage, using the voltmeter, over the range of brake positions 0 - 10 and then tabulate as in fig 7.6.

Be careful that you do not exceed the 2A limiting current.

Repeat the readings for a gain of 10, that is set the gain potentiometer to position 1. Re-adjust the reference potentiometer to give a no-load motor speed of 5000rev/min.

Repeat the experiment for a maximum speed of 500rev/min.

E7.2 Plot your results in the form of graphs of Error voltage against Brake Setting and Speed against Brake Setting for gain values of 1 and 10.

E7.3 Compare the mean regulation for a gain of 1 to 10 by using the changes of speed that occur for changes in torque from brake positions 0 to the current limit of 2A.

Q7.5 What do you think would happen if you continued to increase the motor load and what conclusions do you draw from your observation?

Before carrying out the last part of the assignment we can examine a factor of interest as regards performance and that is the minimum signal needed for the motor to respond, or 'deadband'.

To observe the effect of gain on deadband set the magnetic brake to the no load position and adjust the value of the gain to 10. Slowly turn up the value of the reference voltage till the motor just begins to turn and then measure the value of the reference voltage, tabulating the result as in fig 7.7.

Repeat your reading for a gain set to 1 and then repeat for a gain of 10 with the magnetic brake set to position 10. You should find that the deadband is reduced as the gain increases in both cases.

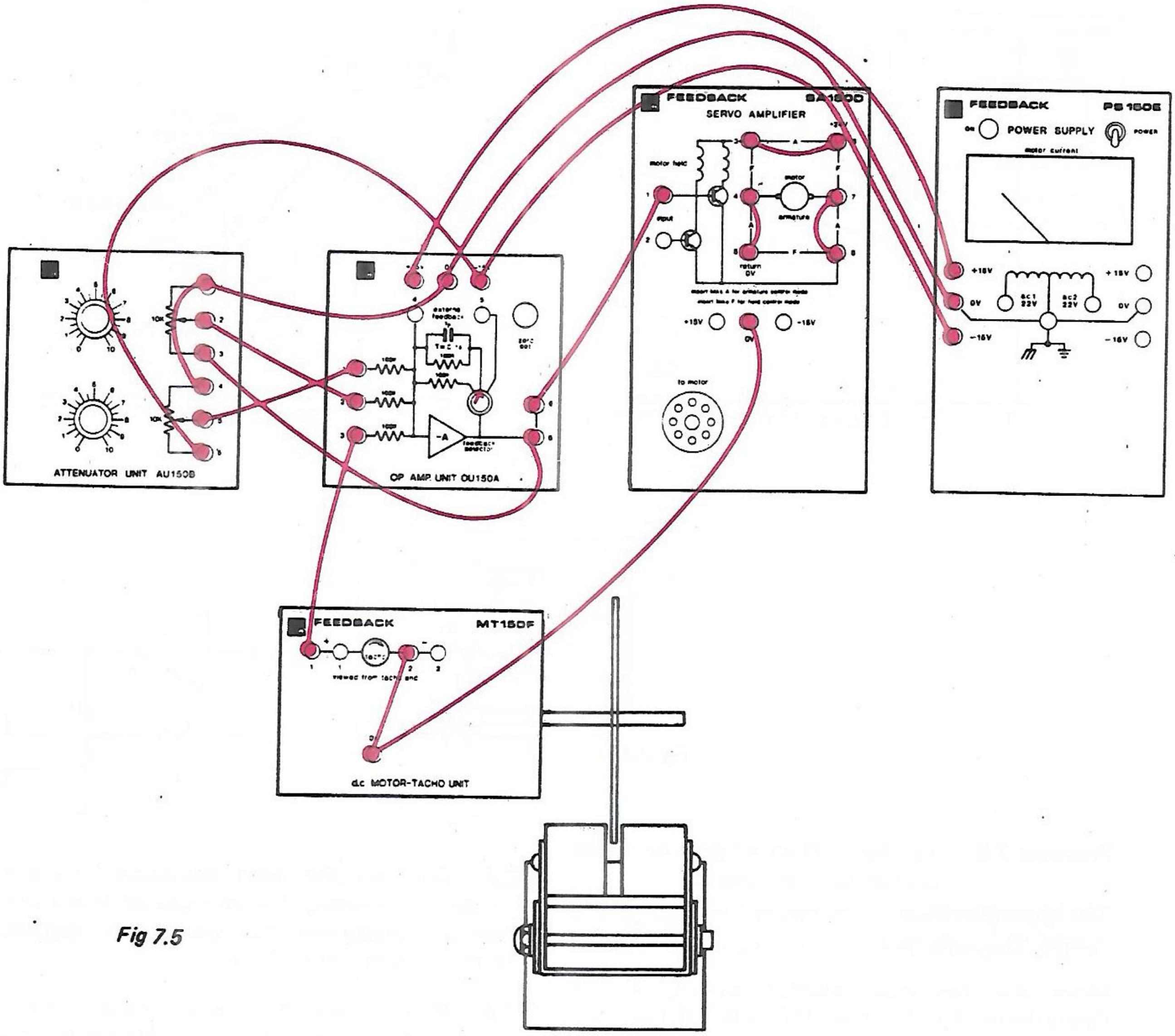


Fig 7.5

brake position	reference volts	error volts	tachogenerator volts	speed rev/min

Fig 7.6

brake position	gain	reference volts

Fig 7.7

The inputs into the Servo Amplifier will drive the motor in opposite directions but both inputs require positive voltages. As the output of the Operational Amplifier varies from positive to negative it is necessary to use the Pre-Amplifier that is so designed that a negative input gives a positive voltage on one output and a negative input gives a positive voltage on the other output, see Assignment 6. The gain is about 25, as you will have found.

In the last part of the assignment the kit will be assembled to form 'a' simple reversible speed control system. From your readings you will have seen that a high gain decreases the minimum reference signal needed for the motor to respond so on this third experiment we will use high gain.

In Practical 7.3:

Apparatus as in Practical 1 but replace Operational Amplifier Unit with Pre-Amp Unit 150C. Set up as in fig 7.8 adjusting the reference to zero output before coupling to the Pre-Amplifier.

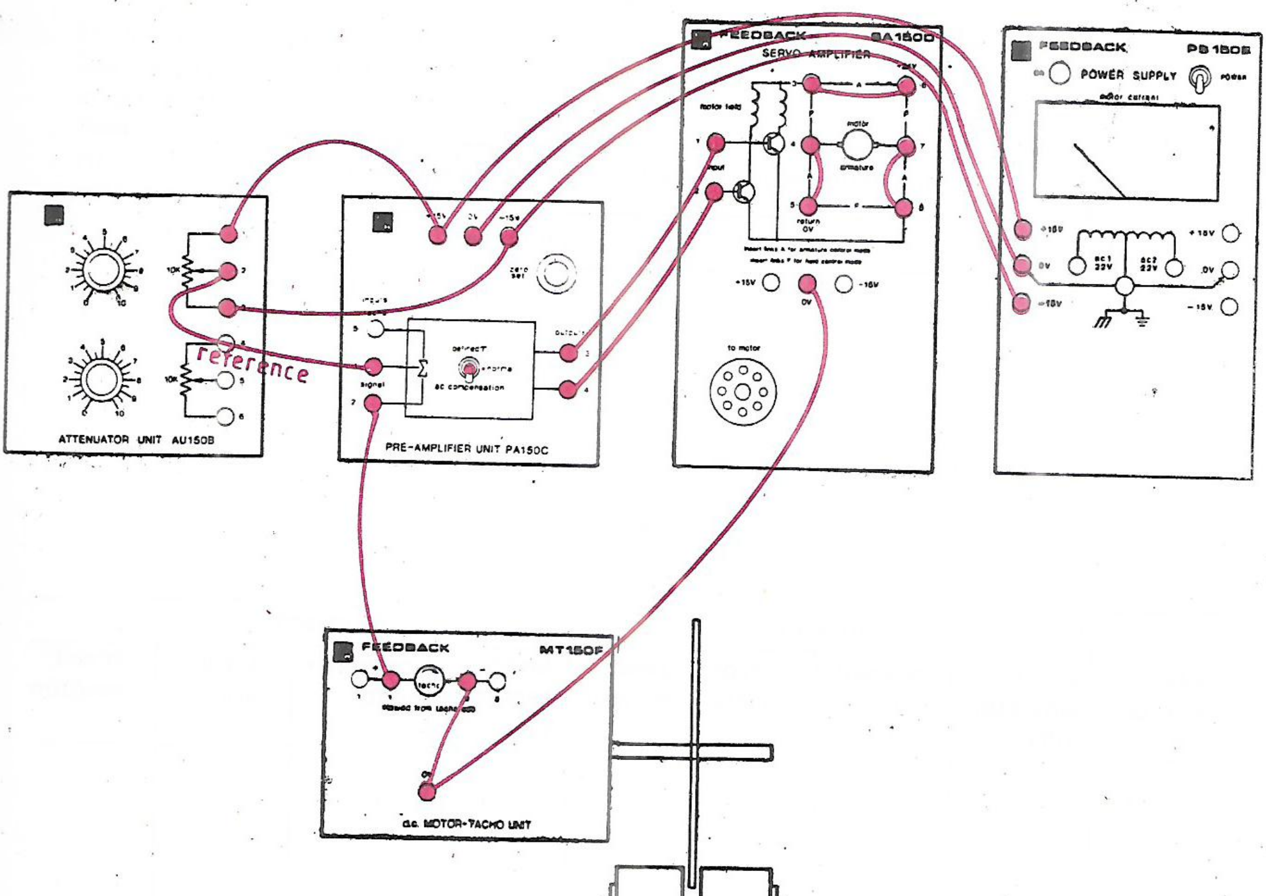


Fig 7.8

Practical 7.3 Demonstration of a simple reversible speed control system

Set the slider on the reference potentiometer to position 5.

With no load on the motor, now find that you can invert the sign of the reference signal so that you can reverse the direction of motor rotation, by slowly turning the reference slider to either side of the centre position. Record the reference voltage that just causes the motor to rotate, as in fig 7.9.

Set the speed of rotation in one direction to 1000rev/min and then take readings over the brake positions 0-10, as in fig 7.10. For measuring the error voltage place the voltmeter across both the Pre-Amplifier outputs.

Then reverse direction and repeat the readings.

PRACTICAL CONSIDERATIONS & APPLICATIONS

So important has the tachogenerator been considered in speed control, that it has very often been made an integral part of the motor.

Examples of speed control can be seen in every branch of industry and transport. They have become particularly important in continuous processes such as in the control of sheet-metal thickness in hot rolling mills, in generators and most industrial motors.

In guidance systems, automatic pilots, lifts and overhead hoists both reverse speed and positional control may be used.

minimum signal needed for motor response	
forward	reverse

Fig 7.9

brake position	forward				reverse			
	tacho-generator volts	reference volts	error volts	speed rev/min	tacho-generator volts	reference volts	error volts	speed rev/min

Fig 7.10

PRELIMINARY PROCEDURE

In Practical 6.1:

1. Attach the Attenuator Unit 150A, Pre-Amp Unit 150C and Power Supply 150E to the Base-plate by means of the magnetic fixings.

2. Connect the Power Supply to the mains supply line. DO NOT switch on yet.

DISCUSSION AND EXPERIMENTAL PROCEDURE

In the previous assignment we found that our input signal could vary from positive to negative but that we could not use its polarity as a means of determining the direction of motor rotation; the magnitude of the signal controlled the speed of rotation. On examining the field windings we found that one transistor would energise one winding for drive in one direction and the other would cause reverse rotation. Now the Pre-Amplifier is able to provide this type of control because if there is a positive voltage on either of its inputs, then one of its outputs becomes positive; whilst if one of its inputs becomes negative, then the other output becomes positive.

Before we use the Pre-Amplifier to control the motor so that it can rotate in both forward and reverse directions, we will carry out a practical to find its characteristics.

Set up as in fig 6.1 and switch on power.

Practical 6.1 To find characteristics of the Pre-Amplifier

On Potentiometer 1, with the voltmeter set the output between the slider and 0V to +1V.

To be able to obtain accurate readings we need a fine control and so we are going to use Potentiometer 2 to give us fractions of the one volt that we have selected.

Connect Terminal 6 of Potentiometer 2 to the slider of Potentiometer 1. This means that the positions 1 to 10 gives us input values in tenths of a volt.

We are now in a position to take output values of the Pre-Amplifier for different values of inputs to see how the amplifier behaves.

For each slider position on Potentiometer 2 take readings with the voltmeter of each of the Pre-Amplifier outputs and 0V as in fig 6.2. After you have done this repeat for the different inputs with the voltmeter across both outputs.

Now connect Terminal 3 of Potentiometer 1 to the -15V supply and repeat your readings.

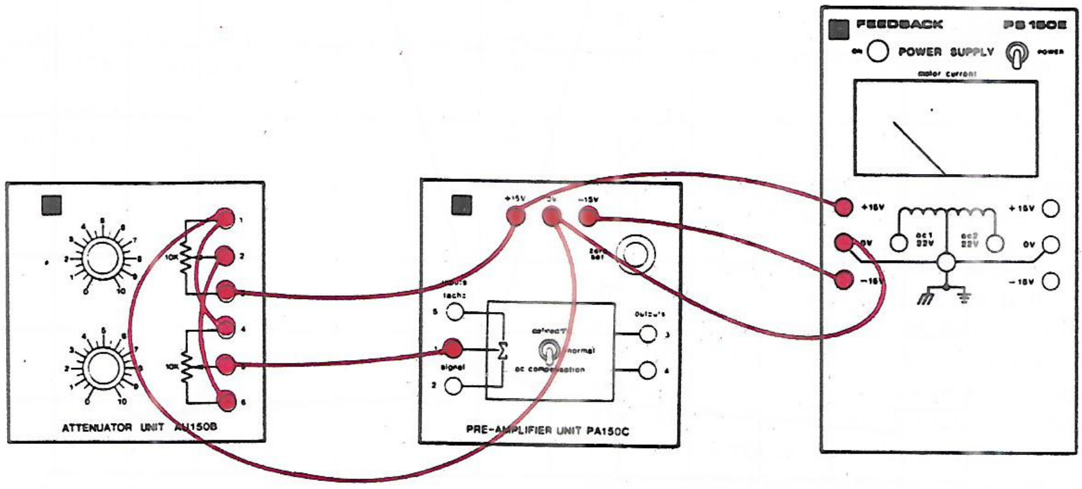


Fig 6.1

input signal V_i volts	pre-amplifier output		
	V_o (3)	V_o (4)	V_o (4-3)

Fig 6.2

E6.1 Plot graphs of the input volts against the output volts as in fig 6.3 and fig 6.4. The curves will depend on how you have connected the voltmeter across the amplifier outputs.

The ratio of the output voltage V_o to the input voltage V_i gives the gain K.

E6.2 Using the straight part of the curves find the gain of the Pre-Amplifier.

Q6.1 State why you should measure the gain on the straight part of the curve.

Q6.2 Explain the reasons for the non-linear portions of the curves.

Q6.3 State the range of signals that you think the input should be kept to.

Q6.4 What input value will give a nil voltage across the outputs?

If the answer to this is not zero it is because there is a zero offset in PA150C. This can be eliminated using the set zero control.

We are now in a position to use the outputs of the Pre-Amplifier to control the motor rotation and provide to it an error signal from the Operational Amplifier. This can be done by combining the circuits of Practical 1 of Assignment 5 with that of this assignment.

Set up as in fig 6.5 using the circuits of Practicals 1 and 2.

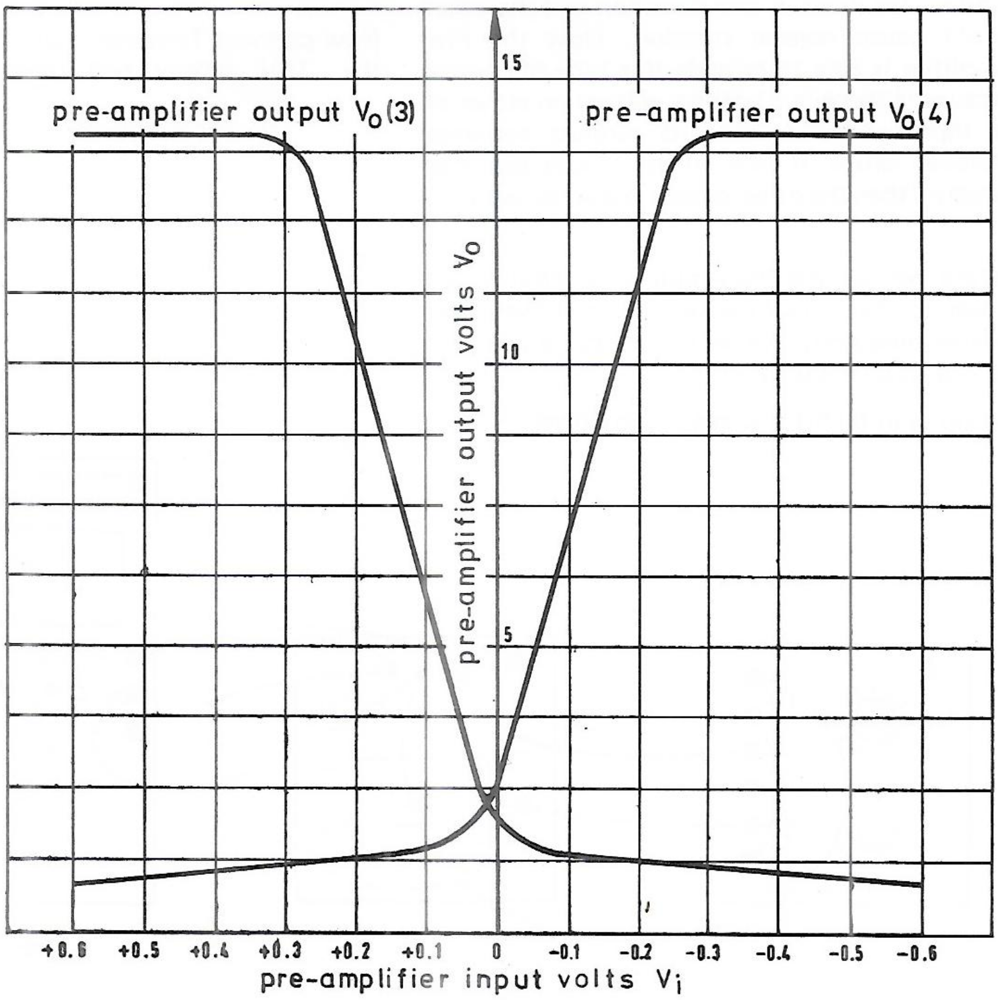


Fig 6.3

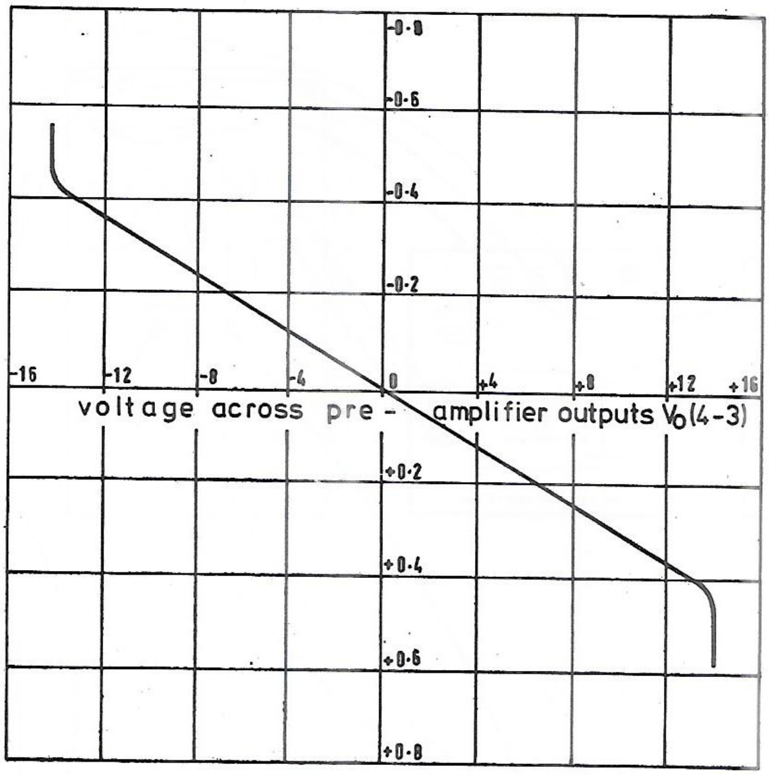


Fig 6.4

Practical 6.2 To demonstrate a simple motor driven closed-loop position control system

This time we shall utilise the error signal output V_o of the Operational Amplifier to drive the output potentiometer via the Pre-Amp and motor.

The potentiometer on the Attenuator can now be used as a gain control and should initially be set to zero (i.e slider to 0V) before switching on the power. The slider should be connected to the input of the Pre-Amplifier. With the gain (Attenuator) set to zero adjust the Pre-Amplifier zero so that the motor does not rotate.

Now set the input potentiometer 150H to some arbitrary angle and increase the Attenuator setting. The output shaft should rotate to an angle nearly equal to that of the Input shaft.

If the output cursor stops before arriving at the set position, one is faced with the fact that the system is tolerant to an error and the motor will not respond till the error exceeds a certain value. In the next assignment we shall study this effect, which is known as 'deadband'. For the purpose of this practical, increase the gain so that this tolerance is overcome and you get the correct alignment.

E6.3 Note the different results obtained in fig 6.6 for several settings of the input shaft angle.

In Practical 6.2:

1. Retain the units of item 1 in the first practical and also attach the Operational Unit 150A, Motor Unit 150F and Input and Output Potentiometers 150H and 150K to the Baseplate by means of the magnetic fixings.

2. Connect the Servo Amplifier connector plug into the Power Supply.

3. Connect the Motor Unit connector plug into the Servo Amplifier.

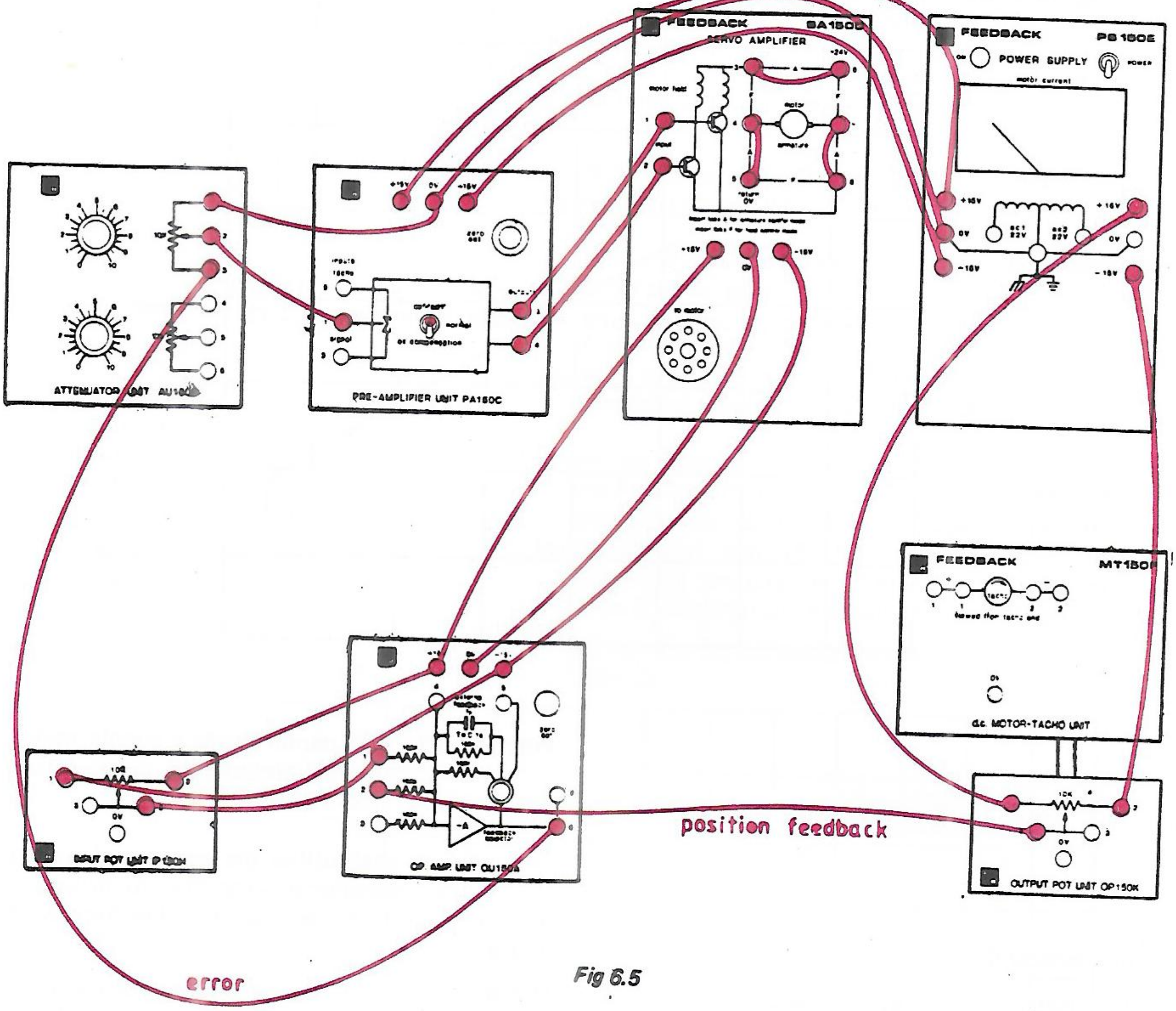


Fig 6.5

output cursor position in degrees		
required	actual	misalignment

Fig 6.6