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Digiplan, Compumotor and Daedal form part of the Parker Hannifin Motion Control Group. Products include stepper, brush and brushless servo systems, controllers and positioning stages, as well as complete custom-designed systems.

Parker

Digiplan

Electronic Motion Control

DS Series Brushless

Servo Drive User Guide

Parker

IMPORTANT INFORMATION FOR USERS

Installation and Operation of Digiplan Equipment

It is important that Digiplan motion control equipment is installed and operated in such a way that all applicable safety requirements are met. It is your responsibility as a user to ensure that you identify the relevant safety standards and comply with them; failure to do so may result in damage to equipment and personal injury. In particular, you should study the contents of this user guide carefully before installing or operating the equipment.

Under no circumstances will the suppliers of the equipment be liable for any incidental, consequential or special damages of any kind whatsoever, including but not limited to lost profits arising from or in any way connected with the use of the equipment or this user guide.

SAFETY WARNING

High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. ***KEEP WELL CLEAR*** of any machinery driven by stepper or servo motors. Never touch it while it is in operation.

High voltages exist within enclosed units, on rack system backplanes (motherboards) and on transformer terminals. Keep clear of these areas when power is applied to the equipment.

SUPPLEMENT

Using the DS drive with DSM Series servomotors

IMPORTANT - be sure to read this section ***before*** you apply power to the drive.

The main part of this manual gives the information you will need for the mechanical and electrical installation of the DS Series servo drive. When using Digiplan DSM Series servo motors you will need to refer to the connection details given in this section. You will also find the parameter values needed to configure the drive to suit the particular motor you are using.

Connections using Digiplan pre-wired cables
These cables are fitted with motor-end connectors only, allowing the cable to pass through conduit or cable glands. The drive end of the cable is ready prepared with the individual leads identified. Mating drive-end connectors are supplied with the drive and are attached by means of screw terminals.

Motor cable (the larger of the two cables)
Connect this cable to the power connector at the top of the drive. The pins are identified on the front panel of the drive.

Lead no.	Drive terminal	Signal
A	Motor A	Motor phase 1
B	Motor B	Motor phase 2
C	Motor C	Motor phase 3
E	Earth	Earth (ground) line

Resolver cable

Lead no.	Drive terminal (connector B)	Signal
1	1	Thermistor A
3	3	Thermistor B
18	18	Cable screen
20	20	Cosine low
21	21	Cosine high
22	22	Sine low
23	23	Sine high
24	24	Excitation low
25	25	Excitation high

Note that terminal 1 on the drive is a multi-function input which can be used as an external trip, external current limit or thermistor input. When used as a thermistor input a 1K5 resistor must be fitted between terminals 1 and 2 (see diagram A).

Brake connections
When the motor is fitted with the optional brake, connections are made to leads 4 and 5 on the resolver cable. To release the brake, 24V DC must be applied to these leads(positive on lead 4).

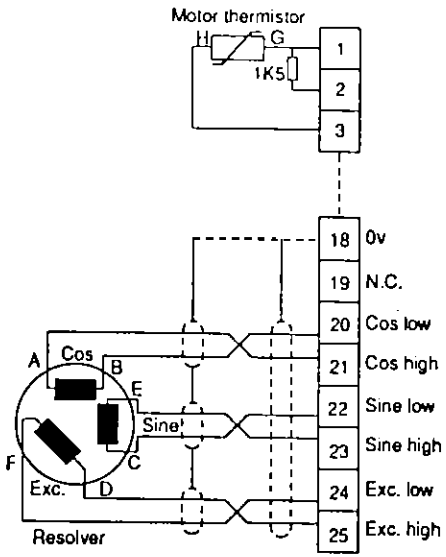
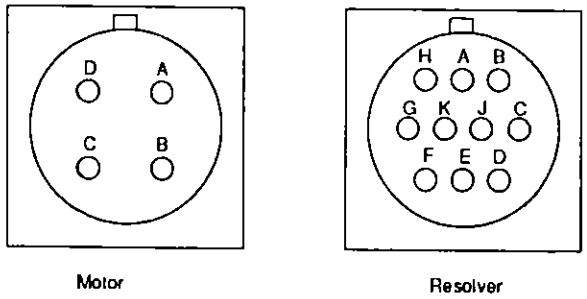


Diagram A. Resolver & thermistor connections

Connections for user-supplied cables
The following tables show the connections required when you make up your own motor & resolver leads (please refer also to Section 4). Recommended cable sizes are given in Section 2. The resolver cable should contain twisted pairs with individual screens as well as an overall screen.



Pin orientation is viewed from the wiring side of the mating plug

Diagram B. Motor & resolver connections

Motor cable

Motor plug	Drive terminal	Signal
A	Motor A	Motor phase 1
B	Motor C	Motor phase 3
C	Motor B	Motor phase 2
D	Earth	Earth (ground) line

Resolver cable

Resolver plug	Drive terminal (connector B)	Signal
A	21	Cosine high
B	20	Cosine low
C	22	Sine low
D	25	Excitation high
E	23	Sine high
F	24	Excitation low
G	1	Thermistor A
H	3	Thermistor B
J	-	Brake +24V (if fitted)
K	-	Brake 0V (if fitted)
-	18	Cable screen

Initial Settings
Turn on the drive but leave it disabled (terminal B14 open-circuit). Refer to Section 5 which explains how to change parameter values.

Set the nominal current (Pr45) and time constant (Pr55) parameters using the table below. It is important that these parameters are set up before the phasing operation is carried out. The peak current (Pr42) may be left at its default value of 100.

Motor type	Value of Pr45 for different drive types					Value of Pr55
	DS140	DS220	DS420	DS600	DS750	
DSM50340	41					6
DSM50540	50	46				6
DSM50840		50	35			6.5
DSM51140			43	28		7
DSM71430			39	25		8
DSM71930				48	38	8.5
DSM72530					43	9.5

Set b11 = 1 and b56 = 1. This sets up the drive to detect motor overheating via the thermistor input on terminal 1.

Set Pr99 to 4200 if you need to use the full speed range on size 5 motors (DSM50340 - 51140). The default value for Pr99 is 3200 which is appropriate for size 7 motors.

Set Pr95 = 8. This selects 8-pole commutation for DSM series motors.

The default values of all other parameters are appropriate for initial commissioning.

Important - when these initial settings are completed, save the values to EEPROM by setting b99 to 1. Then power off and re-power the drive.

Additional parameters available in software Issue V2.95.

The following parameters are available in V2.95 but are not listed in the main part of the manual.

Pr37 - Position Loop Integral Gain
This gain term improves the ability to hold a specific spindle orientation. The range is 1 to 255, and the default value is 255.

Pr68 - Set Encoder Resolution
This parameter sets the pre-quadrature resolution of the simulated encoder output. After quadrature detection the resolution will normally be four times the quoted figure. The range of Pr68 is 0 to 3, and the default value is 1.

Pr68	Steps/rev
0	256
1	512
2	1024
3	2048

Pr97 - Show Software Issue (read-only)

b14 - Reference Select
With b14 = 1, the normal analogue reference will be selected. With b14 = 0, the pulse/direction reference is selected (409.6kHz = 3000 rpm).

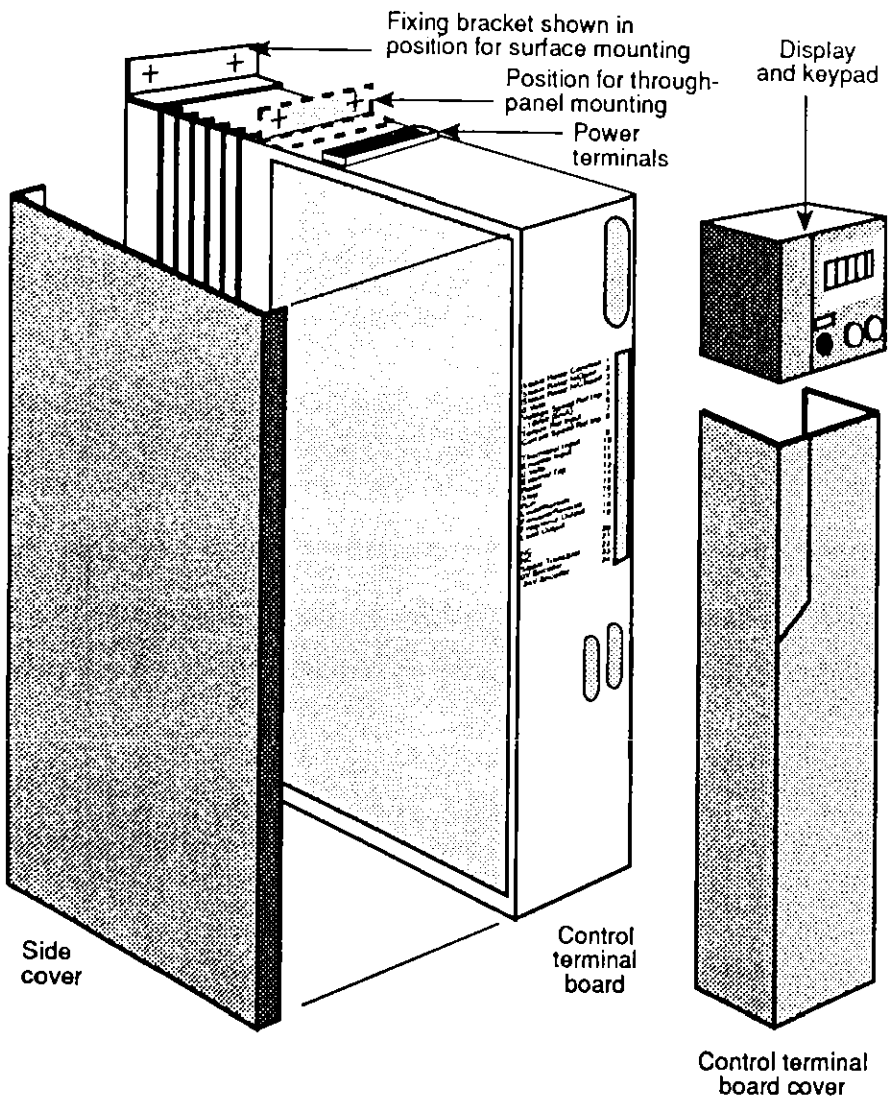
Contents

Illustrations

FEATURES

of the DS Series servodrives

- DS Series servo-drives can be connected directly to the three phase mains supply.
- Control circuits are optically isolated from the power circuit.
- Digital management, by microprocessor,of control input and output.
- On-board switch-mode power supply, braking circuit, heat sink (and cooling fan on appropriate models).
- The power stage is protected against short circuits, overcurrent, overvoltage, and excessive temperature rise.
- Customising adjustments to control parameters can be performed and stored in the removable display-keypad, or through full duplex RS485 serial link from a remote terminal or host computer.
- Immediate recall of last-stored user-entered parameter settings. This feature is a considerable advantage during the process of commissioning a drive and



1 Locations of the principal components of the DS Series servo-drive.

servosystem. Also, immediate recall of default settings of parameters may be useful in many circumstances.

- Display-keypad module can be transferred, complete with stored customising data, to another drive module.
- Dedicated terminals for resolver input.
- For position controllers or CNC, simulated A/B/index encoder signals are provided at dedicated output terminals.
- Limit switch signals, stop-hold, and shaft-orientation functions are controlled by programmable parameters and control input terminals.
- Acceleration and deceleration ramps are programmable independently from each other and with reference to the direction of motor rotation, and can be disabled by programmable functions.
- Diagnosis is facilitated by a menu of fault codes displayed at the keypad. Fault codes are readable through the serial link.
- Last-fault function is stored in non-volatile memory for interrogation.
- Physical separation of power cabling relative to control wiring.
- Current-limiting resistor in the dc circuit to prevent excessive inrush current at power-on.

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1
Introduction

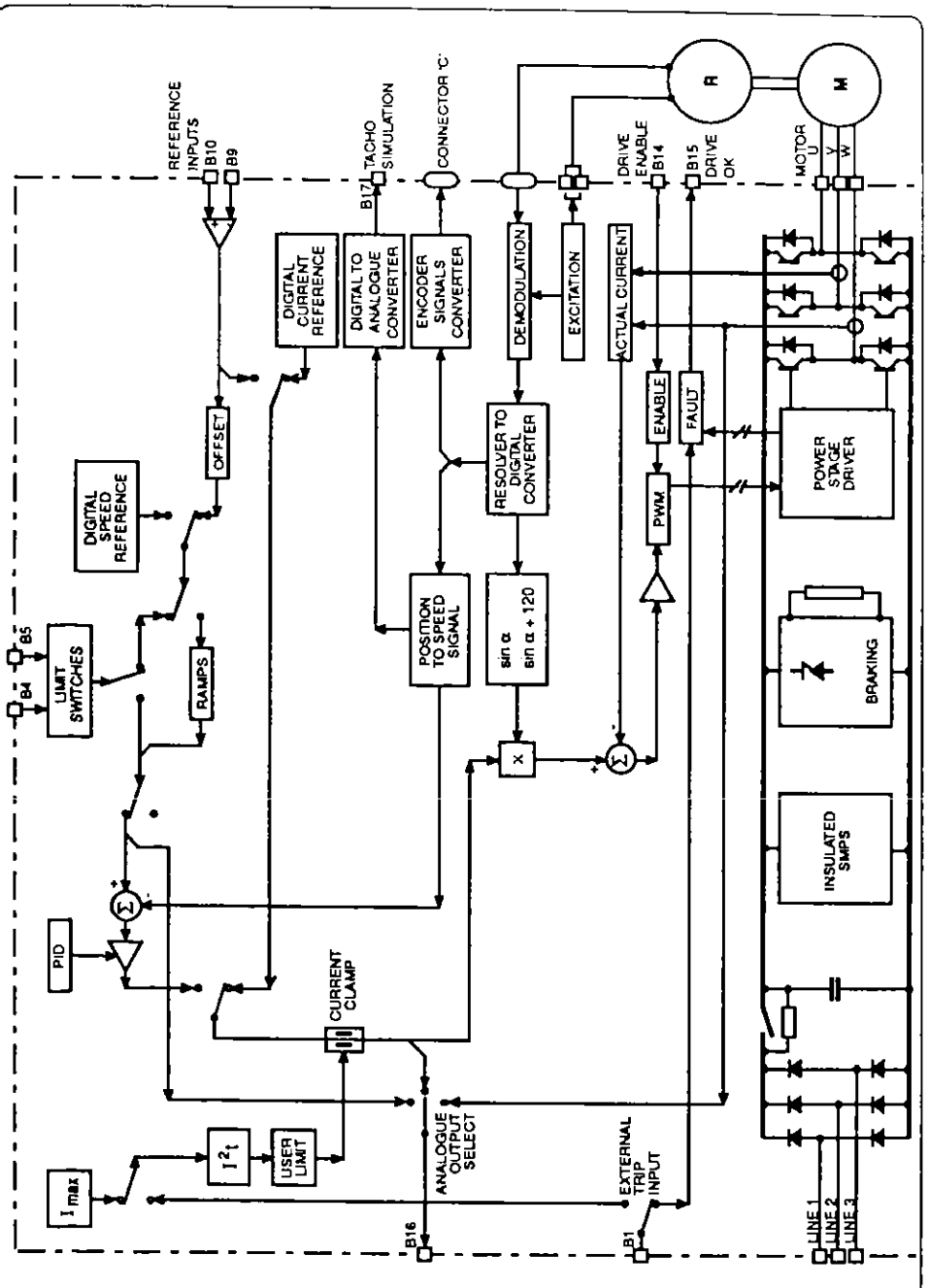
DS Series servodrives are designed to operate in one of two modes — speed reference, or current reference. The outline of the control system is shown, without detail, in Fig. 2. In speed control mode, the reference may be provided by an external source or by internal programmable references. The external analogue reference is converted to a digital signal, at which point there is provision to correct any offset inherent in the source of the signal. The speed reference may operate with or without acceleration and deceleration ramps. The reference is algebraically summed with the speed feedback signal to produce an error signal.

In current control mode, the current reference is applied directly at the same summing junction where it is compared with current feedback to produce an error signal.

The error signal, from speed or current input reference, passes to a PID filter to produce a current reference. This is subject to limitations applied to prevent overcurrent and overheating, and can also be subject to an external limit. The programmable factors employed to establish the automatic limitations are related to the requirements of the overall servo-system and to the constraints imposed by the motor specification and its thermal image.

The current reference is compared with the actual current circulating in the motor and with the resolver feedback to produce a final current reference for the PWM control of the power output stage.

Auxiliary external control facilities include provisions for a drive-enable signal, drive stop-and-hold, stop controlled by limit switches, and an optional external current limit



2 DS Series servo-drives system.

(previously mentioned). Decelerating ramps can be applied to all stop functions if required.

A DS Series drive can be controlled entirely at the keypad or through an industry-standard serial link. There are extensive provisions for the output of signals and data to

interface the drive with others or with external control devices. Internal data and status can be interrogated at the keypad or through the serial link.

Default values of the controlling parameters are permanently held in the on-board memory and can be recalled whenever required, but an additional feature is that the customised programming of a DS Series drive is saved in the memory integral with the keypad. As the keypad is demountable, a programme can instantly be applied to a different DS Series module.

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2
Data

2.1 Specifications

INPUT POWER SUPPLY VOLTAGE
Balanced 3-phase 3-wire, 50Hz to 60Hz.
Voltage, minimum 380V -10% to maximum 460V +10%.

OUTPUT VOLTAGES

Motor	Service voltage 380V to 460V ±10%
DC bus voltage	740V maximum

INPUT CONTROL SUPPLIES

Analogue	±10V, 10kΩ impedance.
Digital	Input impedance 15kΩ. = 0 if earthed; =1 if +24V applied.

OUTPUT CONTROL SUPPLIES and REFERENCES

±10V reference ±10%.	10mA drive capability.
Analogue	±10V, 1kΩ impedance.
Digital	Transistor PNP open collector. 10mA drive capability.
Tachogenerator	3V per 1000rpm if full scale is 3000rpm. 3V per 4000rpm if full scale is 6000rpm.
Simulated encoder	Balanced lines driven by line drivers RS422.
+24V supply	100mA drive capability

AMBIENT TEMPERATURE & HUMIDITY
Ambient temperature range 0°C to 50°C.
Maximum ambient temperature 50°C.
Rated maximum altitude 1000m.
Storage temperature range -40°C to +55°C.
Humidity requirement — non-condensing

DERATING
Normal ratings are affected by —

- Ambient temperature. Maximum permissible for the installation, 50°C.
- The altitude of the installation. Where the site is above 1000m, reduce the normal full load current by 1.0% for each additional 100m.

SERIAL INTERFACE
RS485 full duplex.

INGRESS PROTECTION (IP) ENCLOSURE
DS Series servo-drives are constructed in accordance with IP20 specification.

2.2 Ratings

1 OUTPUT and LOSSES

Drive Model	*Apparent power* kVA	*Nominal continuous current rating* A	*Peak current* A	*Losses* W
DS140	1.3	2.8	5.6	70
DS220	2.6	4.4	8.8	110
DS420	4.3	8.5	17.0	210
DS600	8.7	13.0	26.0	300
DS750	12.9	16.0	32.0	375

2 FUSES and CABLING

Drive Model	*Recommended fuse ratings † at 380V* A	*Typical * cable size* mm^2
DS140	6	1.5
DS220	10	1.5
DS420	16	2.5
DS600	16	2.5
DS750	20	4

* The cable sizes are for 3-core and 4-core pvc-insulated armoured cable with copper conductors, and laid in accordance with defined conditions.

† As a current peak may appear at power up, because of the effect of the dc link capacitor, the use of HRC (high rupturing capacity) fuses is recommended.

As an alternative to fuses, mcbs or mccbs may be used if equipped with thermal and magnetic trip.

CONTROL WIRING

Recommended cross-section 0.5mm^2 (AWG 20).

3 EARTH CONNECTIONS

It is recommended that an earth bus bar of high-conductivity copper should be installed as close as possible to the servo-drive module(s), to minimise the length of the cable connection. Suggested dimensions are —

Thickness 5mm or 6mm

Width

length m	*width* mm
<0.5	20
0.5<1.0	40
1.0<1.5	50

One cable only should connect the frame of each drive to the earth bus. (Please also refer to Fig. 6 page 4.4.) The bus bar should be mounted on insulated supports.

4 VENTILATION

DS Series modules do not require external fans. Cooling fans for the heat sinks are built into those modules that require them.

DS Series servo-drives may be installed in an enclosure, but care must be taken ensure that there is adequate space for the free circulation of air within the enclosure. In particular, it is not advisable to locate a drive or drives vertically above others, or above any other kind of heat-producing apparatus.

5 BRAKING RESISTORS

Drive model	*Resistor size*	*Maximum regenerative power*
DS140 DS220	80Ω, 150W	1.5kW for 10s, continuous rating, with a minimum cooling time of 90s.
DS420 DS600 DS750	40Ω, 300W	3kW for 10s, continuous rating, with a minimum cooling time of 90s.

2.3 Electromagnetic Compatibility

IMMUNITY

If the instructions in this guide are observed, DS Series servo-drives exhibit excellent immunity to interference from external sources. In accordance with normal good practice, relays, contactors and switches in power circuits adjacent to the drive should be fitted with suppressors if they control inductive loads.

EMISSIONS

Because of the fast semi-conductor switches used to ensure high electrical efficiency, PWM drives emit some radio-frequency energy, mainly by conduction through the input supply and the motor cables. It is possible for this energy to disturb nearby communications or measuring systems if they are sensitive in the frequency range 100kHz to 10MHz.

Motor Cable

The motor cable carries the highest radio-frequency voltage and current. The electric and magnetic fields associated with the cable diminish rapidly with increasing distance, and sufficient attenuation can usually be achieved by ensuring the segregation of signal cables to at least 0.3m from the motor cable. Parallel runs exceeding about 10m should be avoided if possible.

Emission from the motor cable can be greatly reduced by using a screened or armoured cable. The best effect is obtained if the screening is earthed at both ends — to the motor frame and to the drive earth terminal.

Supply Cable

If emission into the supply causes trouble, a suitable filter must be installed. The supplier of the drive should be asked to advise.

3
Installation Mechanical

3.1 Mounting

DS Series servo-drives are to be installed only in a vertical position, to ensure the best flow of air for the cooling fins of the heat sink. Installation vertically above other drives or any heat-producing equipment may result in overheating.

Location

The installation should be located in a place free from dust, corrosive vapours, gases and all liquids.

Care must also be taken to avoid condensation of vaporised liquids, including atmospheric moisture. If the drive is to be located where condensation is likely to occur when the drive is not in use, a suitable anti-condensation heater must be installed. The heater must be switched OFF when the drive is energised. An automatic changeover switching arrangement is recommended.

DS Series drives are not to be installed in classified hazardous areas unless correctly mounted in an approved enclosure and certified. (Refer also to HAZARDOUS AREAS, page 4 - 1.)

Fixing brackets

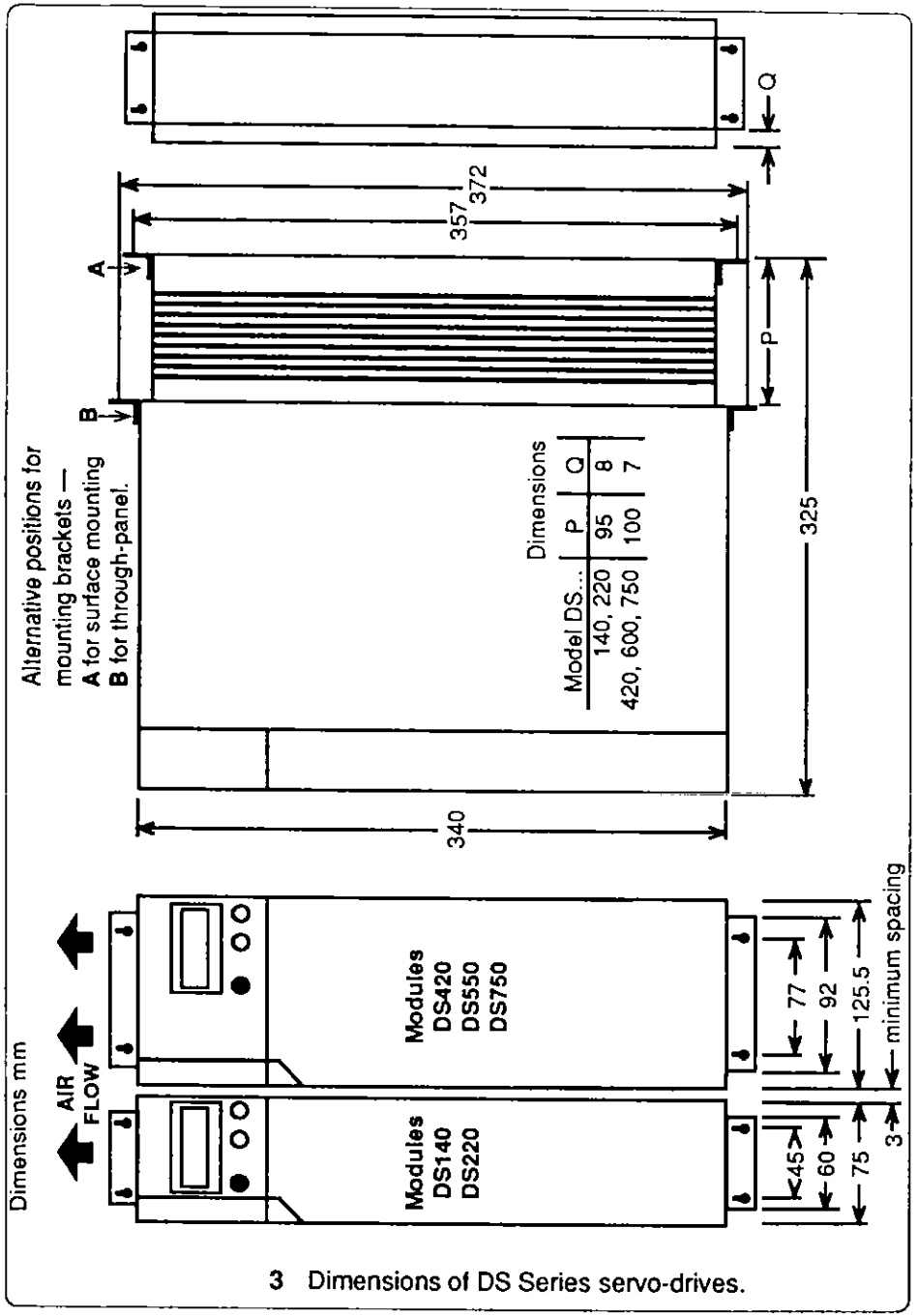
Two alternative arrangements are provided for in the design of the DS Series servo-drive.

Either —

- the drive may be mounted on an open panel or wholly within a cubicle, in which case the fixing brackets are located in position A, Fig. 3 (also Fig. 1), or —
- the heat sink may project through the mounting panel into a free air space behind, in which case the fixing brackets are located in position B.

The fixing brackets are attached to the material of the heat sink or to the frame of the drive by two screws each. Self-tapping screws are provided, to ensure good earth connection to the supporting framework or cubicle which should itself be bonded to earth in accordance with good practice.

Where two or more drives are to be installed side-by-side there must be a gap, 3mm minimum, between adjacent modules to facilitate removal of the the front terminal cover.



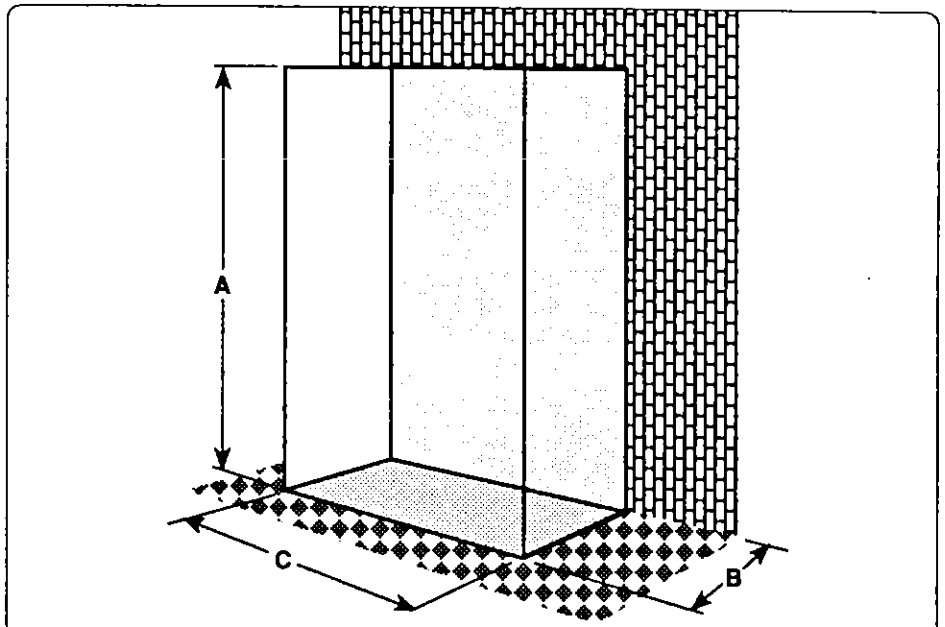
3 Dimensions of DS Series servo-drives.

3.2 Cooling and Ventilation

DS Series servo-drives are protected from damage caused by overheating. A thermal sensor is mounted on the heat sink. If the temperature rises to 95°C, the drive trips automatically. This setting is not adjustable.

Cubicle-mounted DS Series servo-drives can be mounted either wholly enclosed, or with the heat sink projecting though the rear panel. Through-panel mounting allows for physical segregation between the control section of the drive and the power electronics, enabling the heat-producing (power) section to dissipate heat without affecting the temperature within an enclosure. This may be an advantage when a number of drives are to be enclosed in a single cubicle. In any case, cubicle size must be verified by calculation to ensure that there is adequate space to allow free circulation of the air within an enclosure. All equipment in the enclosure must be taken into account in calculating the internal temperature. Installation vertically above other drives or any heat-producing equipment may result in overheating.

As standard, all models of DS Series servo-drives are equipped with an on-board braking resistor. For special applications, some servo systems may require braking capacity in excess of the standard. A larger braking resistor can be connected (models DS420, DS600 and DS750 only) externally to the drive. The on-board resistor must be



4 Enclosure with typically two surfaces not able to disperse heat.

disconnected. When an external resistor is fitted it is vitally important to take account of the increase in heat generated. It is recommended that the resistor should be mounted where its heat losses cannot affect the drive.

To find the dimensions of an enclosure

If a cubicle is to be fabricated to suit the installation, there is a free choice of dimensions. Alternatively, it may be decided to choose a cubicle from a range of standard products. Either way, it is important to take into account the dimensions of the drive module, and to ensure adequate clearance for air circulation.

The procedure is to estimate two of the dimensions — the height and depth, for example — then calculate the third, and finally check that it allows adequate internal clearance.

The effective surface area A_e for an enclosure containing equipment which generates heat is calculated from the following equation —

$$A_e = \frac{P_l}{k(T_i - T_{amb})}$$

where A_e = Effective heat-conducting area, in m^2, equal to the the sum of the areas of the surfaces which are not in contact with any other surface.

P_l = Power loss of all heat-producing equipment in Watts.

T_i = Maximum permissible operating temperature of the drive module in ^oC.

T_{amb} = Maximum external ambient temperature in ^oC.

k = Heat transmission coefficient of the material from which the enclosure is made.

The effective heat-conducting area of a cubicle typically located on the floor and against one wall, Fig. 4, is —

$$Ae = 2AB + AC + BC$$

where A is the cubicle height, B is the depth, front to back, and C the width.

Suppose the cubicle height A is 1.8m, and the depth B is 0.5m, as a first estimate. The actual figures chosen in practice will be guided by available space, perhaps, or standard enclosure sizes.

Since A_e can be found, and A and B are known, the dimension to be calculated is C. The equation needs to be rearranged to enable C to be found, thus —

$$A_e - 2AB = C(A + B)$$

or,
$$C = \frac{A_e - 2AB}{A + B}$$
$$= \frac{2.9 - (2 \times 1.8 \times 0.5)}{1.8 + 0.5}$$
$$= \frac{2.9 - 1.8}{2.3}$$
$$= 0.5\text{m approx}$$

Clearance on either side of the drive module must be checked. The width of the module is 250mm. Clearance of 100mm is required on either side. So the minimum internal width of the enclosure must be 450mm, or 0.45m. This is within the calculated width, and therefore acceptable.

However, it allows no space for any equipment to either side of the drive, and this may be a factor in deciding the proportions of a suitable enclosure. If so, modify the calculated value of C to allow for other equipment, and re-calculate either of the other two dimensions by the same method.

If an enclosure is to be selected from a stock catalogue, the corresponding surface area should be not less than the figure calculated above for A_e.

As a general rule, it is better to locate heat-generating equipment low in an enclosure to encourage internal convection and distribute the heat. If it is unavoidable to place such equipment near the top, consideration should be given to increasing the dimensions of the top at the expense of the height, or to installing internal 'stirrer' fans with drive modules which have no fans of their own to ensure air-circulation.

Enclosure ventilation

If a high IP rating is not a critical factor, the enclosure can be smaller if a fan is used to exchange air between the inside and the outside of the enclosure.

To calculate the volume of ventilating air, V, the following formula is used —

$$V = \frac{3.1 \times P_l}{T_i - T_{amb}}$$

where V = Required air flow in $m^3\ h^{-1}$

A_e = Effective heat-conducting area, in m^2, equal to the the sum of the areas of the surfaces which are not in contact with any other surface.

P_l = Power loss of all heat-producing equipment in Watts.

T_i = Maximum permissible operating temperature of the drive module in ^oC.

T_{amb} = Maximum external ambient temperature in ^oC.

k = Heat transmission coefficient of the material from which the enclosure is made.

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4
Installation
Electrical

4.1 Introduction

SAFETY

The voltages present in the supply cables, the output cables and terminals and in certain internal parts of the drive are capable of causing severe electric shock and may be lethal.

IP RATING

The drive enclosure conforms to international enclosure specification IP20. It is therefore necessary to consider the location of and access to the module in the light of local safety regulations applicable to the type of installation.

ELECTRIC SHOCK RISK!

Whenever the drive has been energised, it **MUST be ISOLATED** before work may continue. A period of **TWO minutes MUST** elapse after isolation to allow the internal capacitors to discharge fully. Until the discharge period has passed, dangerous voltages may be present within the module.

Persons supervising and performing electrical installation or maintenance must be suitably-qualified and competent in these duties, and should be given the opportunity to study, and to discuss if necessary, this User's Guide before work is started.

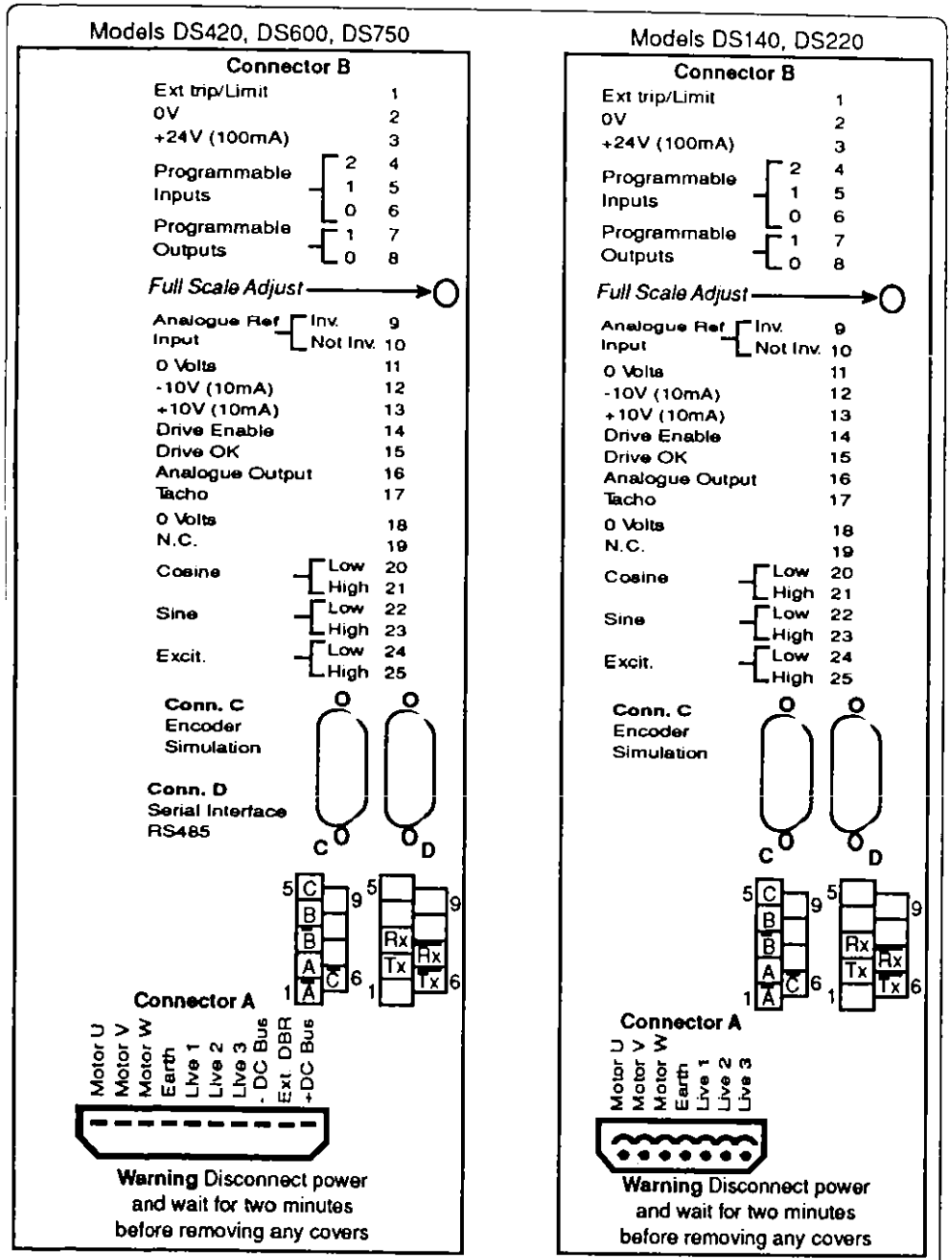
HAZARDOUS AREAS

The application of variable speed drives of all types may invalidate the hazardous area certification (Apparatus Group and/or Temperature Class) of Ex-protected motors. Approval and certification should be obtained for the complete installation of motor and drive. (Refer also to LOCATION, page 3 - 1.)

EARTHING

SAFETY EARTHING

Earth impedance must conform to the requirements of local industrial safety regulations and should be inspected and tested at appropriate and regular intervals.



5 Terminals A, B, C and D. Power terminals A are located on the upper face of the module.

4.2 Power Connections

Refer to Fig. 5.

The power terminals are located on the upper surface of the module. The terminals for the control circuits are on the front, protected by a removable cover (Fig.1). This arrangement enables the power cabling to be run in from above the module and the control wiring from below, with the advantage that the two are well separated for the avoidance of interference with control signals. For cable sizes, please refer to Chapter 2 Section 2.

Protection

The drive must be protected on the supply side either by hrc fuses (for ratings please refer to Chapter 2 Section 2) or by suitably-rated three-phase mcb or mccb switches equipped with thermal and magnetic trip.

Power Circuits Earthing

Earth cable runs should be as short as possible. It is recommended that and earth bus bar should be installed on insulated supports as close as possible to the drive. Earth loop impedance should be verified in accordance with the applicable approved code of practice. For bus bar sizes, please refer to Chapter 2 Section 2.

Screened cable should be used for the output connections to the servomotor. The screen is to be connected to earth at Terminal A4.

4.3 Control Connections

Refer to Figs. 5 and 6.

The control system wiring should be connected to a single earthing point, and arrangements made to ensure that earth loop impedance complies with an authorised code of practice.

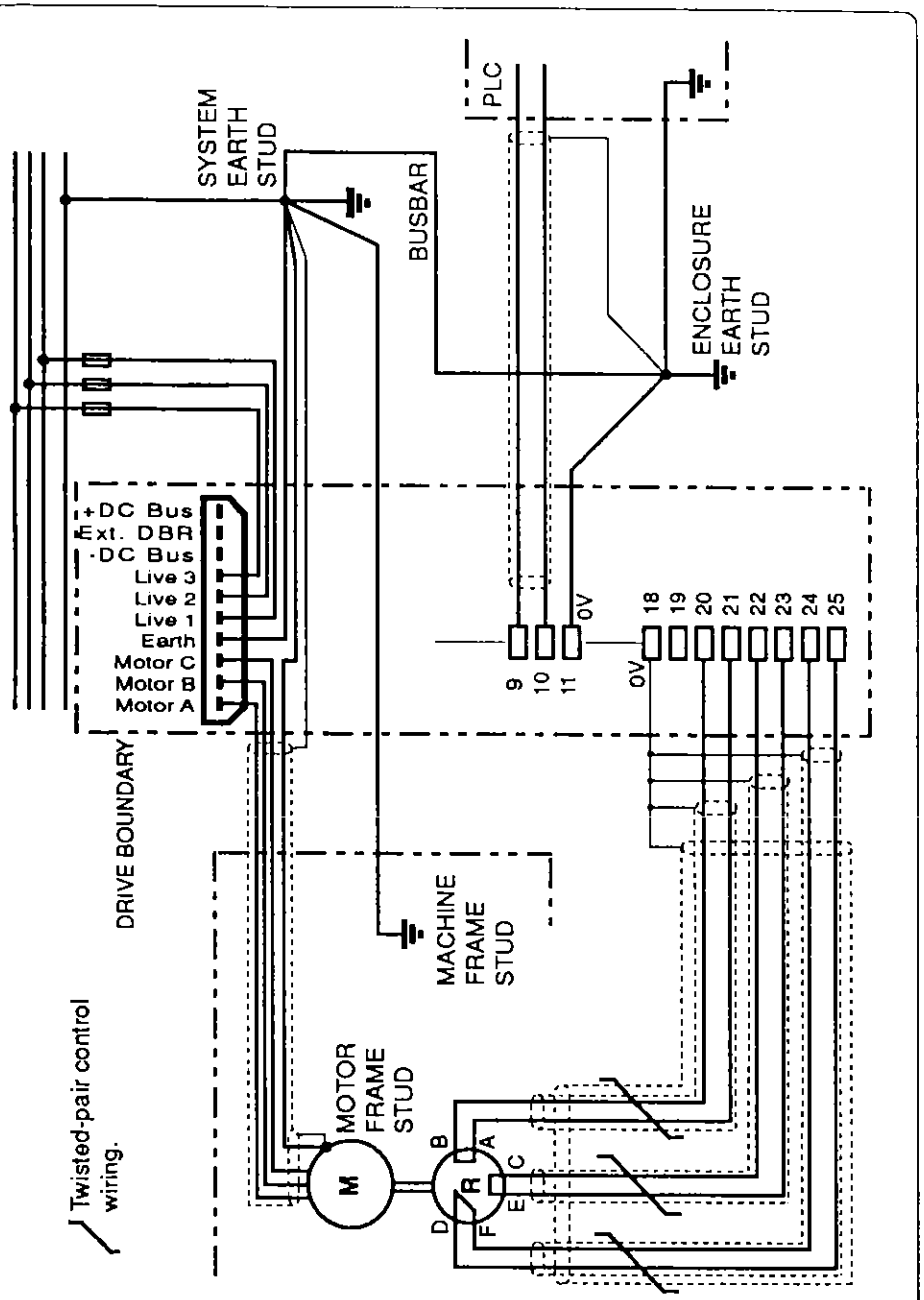
For short runs of less than one metre, control wiring may be of the twisted-pair type.

Resolver Connections

The resolver cable should contain three screened-pairs, PLUS screen overall, Fig. 5. The screening is connected to zero volts at terminal B18.

Serial Link

Full duplex RS485 connection requires two shielded twisted pairs. A standard D-socket receptacle is provided, identified as Conn. D in Fig. 5.



6 DS Series earthing connections.

4.4 Control Terminals

Fig. 5

Power Terminal Board A (Models DS140, DS220)

No	*Function*	*Type*	*Description*
A1	Phase U	out	Output to motor
A2	Phase V	out	
A3	Phase W	out	
A4	Earth		Frame earth common
A5	Phase R	in	Power supply input
A6	Phase S	in	
A7	Phase T	in	

Power Terminal Board A (Models DS420, DS600, DS750)

No	*Function*	*Type*	*Description*
A1	Phase U	out	Output to motor
A2	Phase V	out	
A3	Phase W	out	
A4	Earth		To system earth
A5	Phase R	in	Power supply input
A6	Phase S	in	
A7	Phase T	in	
A8	DC bus negative pole		
A9	External braking resistor		
A10	DC bus positive pole		

Control Terminals B

No	*Name & Function*	*Type*	*Description*
B1	External trip/Limit Aux. Analogue Input	In	Auxiliary analogue input usable as an external current limit or as an external trip monitor (ref **b56**). Example — the input from a motor thermistor.
B2	Zero volts		Control signal common, digital input
B3	+24V (100mA)	out	Power supply to external control circuits Driving capacity 100mA
B4	Programmable Input Digital select./Limit sw.	in	In conjunction with terminal B5 for coding the digital speed selection or limit switch function (ref **b16**)
B5	Programmable Input Digital select./Limit sw.	in	In conjunction with terminal B4 for coding the digital speed selection or limit switch function (ref **b16**)
B6	Programmable Input Zero spd. hold/Orient. +24V positive logic.	in	Digital input with function selectable through **b53**, and **Pr 27** for orientation
B7	Programmable Output	out	Refer to **Pr30**
B8	Programmable Output	out	Refer to **Pr31**
B9	Analogue Ref. Input Inverted	in	Inverted analogue reference Speed or current dependent on **b08**
B10	Analogue Ref. Input Not inverted	in	Analogue reference, not inverted Speed or current dependent on **b08**
B11	Zero volts		Control signals common
B12	-10V (10mA)	out	Voltage reference. Max 10mA.
B13	+10V (10mA)	out	Voltage reference. Max 10mA.
B14	Drive enable	in	Logic input to enable the power stage Drive enabled by +24V at terminal, and **b02** =1
B15	Drive OK	out	Logic output to indicate drive healthy Healthy state indicated by +24V at terminal

No	*Name & Function*	*Type*	*Description*
B16	Analogue Output Programmable	out	Refer to **b12** and **b13**
B17	Tachogenerator	out	Tacho. signal output
B18	Zero volts screen earths		Dedicated connection for resolver
B19	NOT INTERNALLY CONNECTED — DO NOT CONNECT!		
B20	Cosine low	in	0V
B21	Cosine high	in	Cosine signal from resolver
B22	Sine low	in	0V
B23	Sine high	in	Sine signal from resolver
B24	Excitation low	out	0V
B25	Excitation high	out	Signal at 7.812kHz for resolver

B9 POSITIVE WRT B10 CAUSES CW MOTION

continued on page **4 - 8**

A+ LEADS B+ FOR CW MOTION

Simulated Encoder Terminals C

No	Function	Type	Description
C1	A +	out	Channel A of simulated encoder
C2	A −	out	Inverted channel A of simulated encoder
C3	B +	out	Channel B of simulated encoder
C4	B −	out	Inverted channel B of simulated encoder
C5	C +	out	Channel C of simulated encoder
C6	C −	out	Inverted channel C of simulated encoder
C7	Frequency ref.	in	For applications controlled by an indexer +24V
C8	Direction ref.	in	For applications controlled by an indexer +24V
C9	Mode selector ØV	in	+24V selects Frequency/Direction mode reference at C7 and C8. Disables all other Speed References. 0V, or open, selects Analogue/Digital Reference mode.

Serial Link Terminals D

No	Function	Type	Description
D1	GND		Earth
D2	TX	out	Serial transmit signal
D3	RX	in	Serial receive signal
D4	NOT USED		
D5	NOT USED		
D6	TX	out	Inverted serial transmit signal
D7	RX	in	Inverted serial receive signal
D8	NOT USED		
D9	NOT USED		

5
Operating Procedures

5.1 Keypad & Display

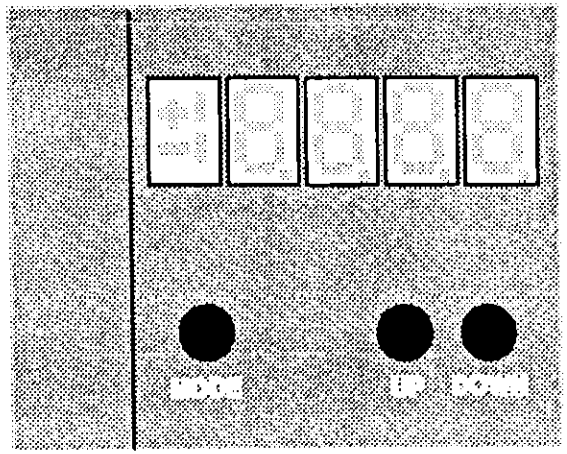
Refer to Fig. 7

The keypad and display panel of DS Series servo-drives is a demountable module which incorporates the programmable non-volatile memory. When removed, the module retains any stored parameter settings. This feature enables the drive module to be replaced without the necessity for re-programming, or the programmed module to be transferred to another drive module. (Modules can only be transferred between drives of the DS140/220 size and, separately, of the DS420/600/750 size, but not between the two sizes.) Before the programming module is removed, the drive must be powered-off.

Three keys on the module enable the user to perform all programming functions. The keys are marked 'mode', 'up', and 'down' — up and down being represented in the text of this Guide by the symbols ⇑ and ⇓. A green LED responds to operation of the mode key.

Display

A five-panel LED display window responds to the actions of the keys, displaying parameter numbers and values in accordance with a simple protocol. Since both Pr and

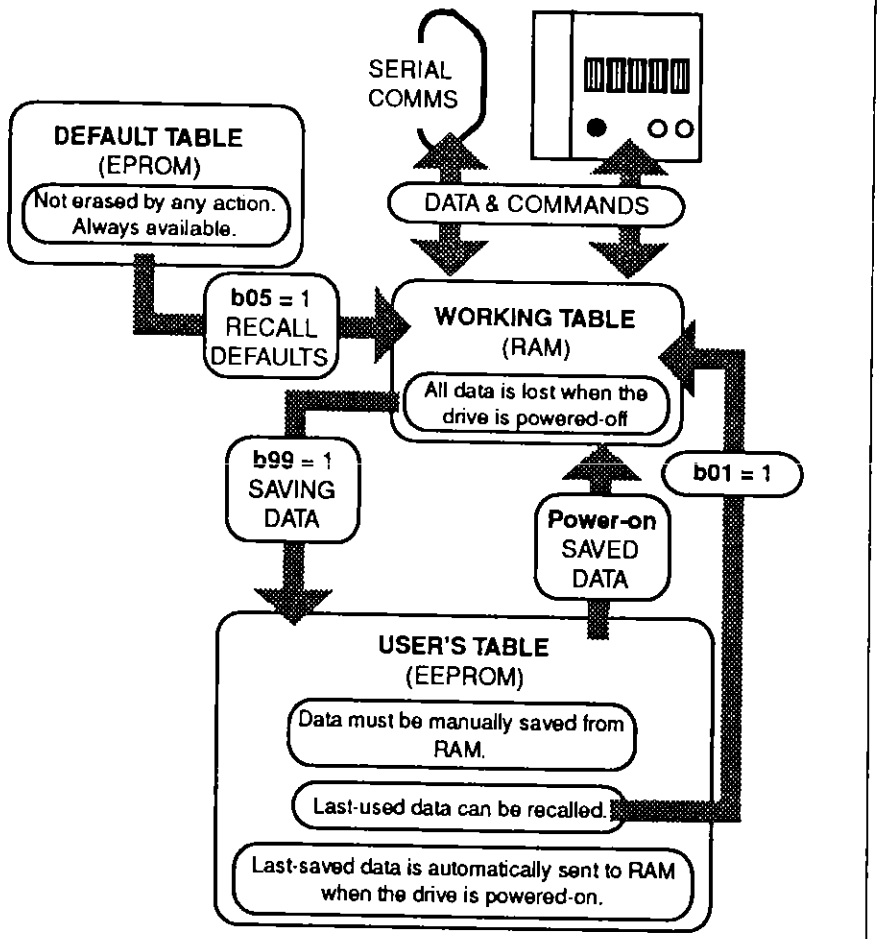


7 DS Series drives, demountable keypad.

bit parameters are numbered from **00** to **99**, they are distinguished in the display by all bit numbers being preceded by a figure **1**. Thus, **Pr00** is displayed as **00**, **b00** as **100**.

The extreme-left panel is dedicated to indication of polarity (+ or -) of values, and to values in excess of 999, for which a figure 1 illuminates.

At power-on, the display, after a very brief pause during the current-inrush period, shows the software version number for a few seconds, then changes to **rdY**, indicating that the drive is ready to receive any command. If any other message is displayed, refer to Chapter 9 Section 2, Fault Finding Procedures.



8 Data storage and recall procedures.

5.2 Manipulation of Parameters

For particulars of parameter manipulation through the serial link please refer to Chapter 10 after reading this section.
When manipulating parameters at the keypad, if no keystroke is made for a period of 8 seconds the display will revert to showing the speed or load (as selected) of the drive. Press MODE to return to the point at which the pause occurred.

1 PARAMETERS

There are two classes of parameters —

- those which have a range of numerical values are represented by **PrXX**;
- those which have bit values (0 or 1) are represented by **bXX**.

Both classes contain parameters of two kinds —

- 'read or write' (R/W), or
- 'read only' (RO).

The R/W parameters are those which the user is able to change to suit the motor and the application, as for example, **Pr01**, digital speed reference, or **b02**, which enables and disables the drive. RO parameters are informative only, containing an item of data about the present value of a variable quantity, such as **Pr24**, the speed reference in rpm, or the status of the drive — for example **b04** shows whether the drive is enabled or disabled.

2 DEFAULT VALUE

All R/W parameters are programmed during manufacture with values which are generally valid for the size of drive and motor. It may be necessary to apply different values to some parameters during commissioning for a particular installation — this subject is treated in detail in Chapter 6 Section 3. Details of all default values are given in Chapter 8 Section 4.

Default values are stored in permanent memory (EPROM) in the drive, Fig. 8, and cannot be erased or changed by the user, but can be recalled at any time (**b05** = 1). This action reads the default values of ALL parameters into the User Table.

NOTE
Setting all parameters to their default values includes the security code, **Pr25**, the default value of which is zero, allowing open access to change any parameter. In other words, security is lost when default values are restored.

3 MEMORY FUNCTIONS

Whenever the drive is powered-on, the contents of the User Table (EEPROM), Fig. 8, are read into the Working Table. When a new drive is *first* powered-on, the User Table contains the default values.
In any single period of use, ie between powering-on and next powering-off, a newly-written (at the keypad or through the serial link) value of any parameter is held in the

Working Table. If that value is then changed, the previous value is remembered by the Working Table and can be recalled by setting **b01** =1. During a period of setting up, when it is often necessary to try the effect of a different value, this facility permits instant return to previous values and avoids the necessity for written notes. All parameters take effect as soon as their value is changed.

When the settings are satisfactory they are saved from the Working Table to the User Table (EEPROM) by setting **b99** =1. The contents of the Working Table are lost upon powering-off.

NOTES

- Setting **b01** =1 recalls the previous values of ALL parameters which have been changed during the present period of use, not only the previous value of the parameter just changed.
- Setting **b99** =1 saves ALL parameter values currently in the Working Table and makes these values active at the next power-on.
- The Working Table and the User Table are located in the programming module, so that parameter values stored as described are unchanged if the module is removed from the drive. The EPROM is located in the drive itself so that default values are unaffected by removal of the programming module.

4 MANIPULATION

The menu of parameters starts at **Pr00** and continues to **Pr99** followed by **b00** to **b99** consecutively. A single keystroke on the ⇑ key moves the display to the next higher parameter number, and on the ⇓ key to the next below. To scroll quickly though, press and hold the appropriate key. The Pr and bit parameters menus follow one another in sequence, so that the next parameter after **Pr99** is **b00**; similarly, the next after **b99** is **Pr00**.

To change a parameter value

If, during the following procedure, no keystroke is made for approximately 8 seconds, the display reverts either to **rdY** if the drive is disabled, or to the present speed if it is enabled. To prevent this, if it would be inconvenient during a period of commissioning or adjustment, first set **b50** =1. It is recommended that **b50** is set to 0 afterwards.

Action	*Effect*
Press MODE	The mode LED illuminates.
	The display shows the number of the last parameter to have been accessed, alternating with its value.
Press ⇑ or ⇓	to look through the menu of parameters to the required number. (The numbers of bit parameters are preceded by a figure 1.)
Press MODE	The present value of the selected parameter will

	appear in the display and remain steady (not flashing).
Press ⇑ or ⇓	to **change** the value of the parameter.
Press MODE	to **implement** the new value. The mode LED extinguishes.

Refer to paragraph 3, MEMORY FUNCTIONS (page 5 - 3) and Fig. 8.

5.3 Security

The Security Code enables the user to prevent protected parameter values from being changed by accident or unauthorised interference. Parameters which can be protected by a Security Code are marked *P* in Chapter 8. The Security Code selected for the drive must be entered before any protected parameter can be changed. All protected parameters are effectively RO under the security procedure.

The Security Code is held in **Pr25**. Bit parameter **b00** is also used in the procedure to prevent the value of the Security Code from being changed accidentally.

As delivered, the drive is in a state of open access to all parameters Even the protected parameters are accessible and can be changed. This is because **Pr25** = 0. The user can, after setting a Security Code, change back to open access if desired, by setting the value of **Pr25** = 0.

To set a Security Code

Action	*Effect*
Press MODE	The mode LED illuminates.
	The display shows the number of the last parameter to have been accessed, alternating with its value.
Press ⇑ or ⇓	to look through the menu to **b00**.
	The present value, **0**, will appear in the display and remain steady (not alternating).
Press ⇑	to **change** the value to **1**.
Press MODE	to **enter** the new value. The mode LED extinguishes.
Press MODE	The mode LED illuminates. The display shows **b00** alternating with **1**.
Press ⇑ or ⇓	to look through the menu to **Pr25**.
	The present value, **0**, will appear in the display and remain steady (not alternating).
Press ⇑	to **change** the value to any number from 1 to 9999.

Press MODE	to **enter** the new value. The mode LED extinguishes.
Press MODE	The mode LED illuminates. The display shows 25 alternating with the chosen security code for this drive.
Press ⇑ or ⇓	to look through the menu to **b99**.
	The present value, **0**, will appear in the display and remain steady (not alternating).
Press ⇑	to change the value to **1**.
Press MODE	to **enter** the new value. The mode LED extinguishes.

At this stage, the security code is set, but only in the User Table (EEPROM). To **activate** the new security code the drive has to be powered-off. If continuing to use the drive, wait 5 seconds approximately before power-on.

To Change a Parameter Protected by the Security Code

Action	*Effect*
Press MODE	The mode LED illuminates.
	The display shows the number of the last parameter to have been accessed, alternating with its value.
Press ⇑ or ⇓	to look through the menu to **Pr25**.
Press MODE	The value, **0**, will appear in the display and remain steady (not alternating).
Press ⇑	to **change Pr25 to whatever** number is the correct security code for the drive.
Press MODE	to **enter** the code. The mode LED extinguishes.

All protected parameters can now be accessed freely during the period that the drive remains powered-on. After every power-off and -on, it will be necessary to enter the security code to gain access to change protected parameters. All parameters can be read without need for the security code.

To Change the Security Code

To change the code number assigned, first follow the procedure 'To Change a Parameter...' as above to gain access to **Pr25**, then follow the procedure 'To Set a Security Code', page 5-5.

6

Commissioning

In reading this chapter it will be found helpful to study and refer to the Logic diagrams of the control system and the Mode Selector diagrams in Chapter 11.

6.1 Default Status

The as-delivered condition of a DS Series drive is as follows —

- Speed reference is analogue ±10V, at terminals B9 and B10.
- Acceleration and deceleration ramps are disabled (**b07** = 0).
- Software is enabled. To enable the drive, a 24V (positive logic) signal is applied to terminal B14.
- Limit switch control function is enabled (**b16** =1). Connect limit switch signal wiring to terminals B4 and B5.
- Analogue output terminal B16 is configured to indicate motor current (**b12** =1).
- Analogue output terminal B17 indicates the simulated tachogenerator signal.
- Digital output terminal B7 is configured for I^2t limitation (**Pr30** = 0)
- Digital output terminal B8 is configured for temperature pre-alarm (**Pr31** =1)

6.2 Connections

1 POWER

Make power wiring connections in accordance with Chapter 4 Section 2.

2 CONTROL

Make control wiring connections in accordance with Chapter 4 Section 3.

6.3 Preliminary Settings

Refer to Fig. 9

Settings of **Pr42**, **Pr45** and **Pr55** should be carefully considered at this stage and in conjunction, as they affect directly the protection of the motor and the security of the servo-system.

A significant feature of servo applications is the necessity to accelerate rapidly to a high speed. Servo-motors are designed for this. Low inertia of the armature is one factor. The other is the ability to accept, for a short time, a current level I_{max} in excess of the level I_{nom}, the 'nominal' current at which a motor can operate indefinitely. The provision made for precise specification of these current levels in DS Series drives is one of the important customising features.

1 MAXIMUM CURRENT

A drive can deliver any level of current up to the maximum for which it is rated. This maximum is marked on drive nameplates as I_{pk}. However, provision is made for the maximum current output to be limited to a lower value if some aspect of the servo-system requires it. The actual maximum current that the drive is programmed to deliver is I_{max}, entered in parameter **Pr42** as a percentage of the rated I_{pk}, and determined by the equation —

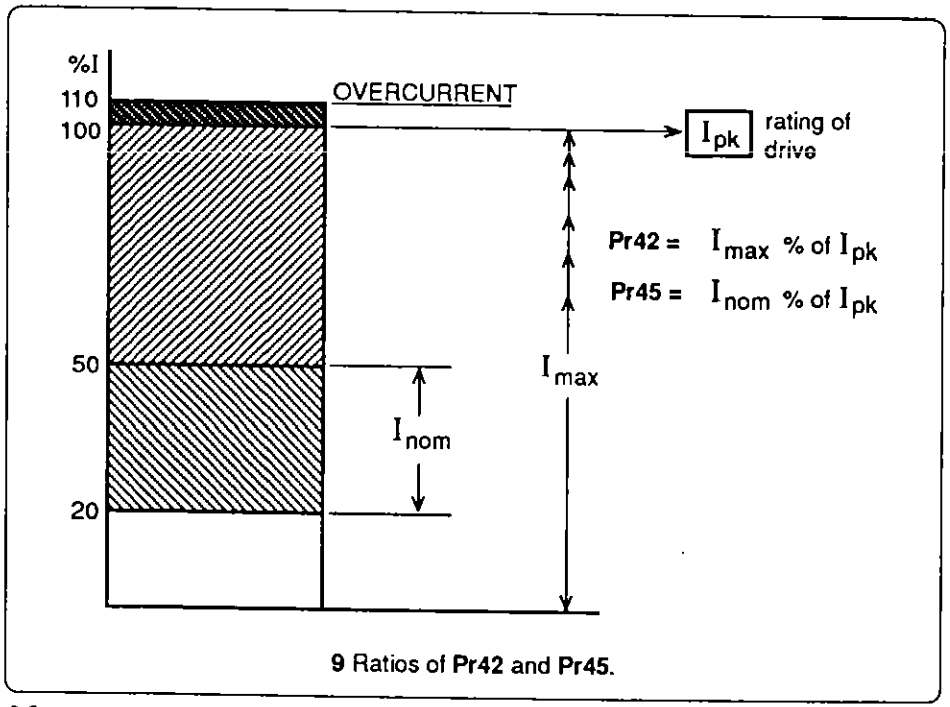
$$\textbf{Pr42} = \frac{I_{max}}{I_{pk}} \times 100$$

The default value of **Pr42** is 100 which is the rated value of I_{pk}, and will be the value of I_{max} more often than not.

Thus, maximum current I_{max} is decided by user with respect to the motor and the application, and may be any value up to 100% of the maximum output current rating, I_{pk}, of the drive. For example, if I_{pk} is 6.6A and I_{max} (the desired maximum current) is 5A, then —

$$\textbf{Pr42} = \frac{I_{max}}{I_{pk}} \times 100 = \frac{5}{6.6} \times 100 = 75.75\%$$

As the resolution of **Pr42** is 1(%), the value entered would be 75 in this example.



9 Ratios of **Pr42** and **Pr45**.

2 NOMINAL CURRENT

Provision is also made to specify the rated maximum current at which the motor is able to operate indefinitely without overheating (in the specified ambient conditions). This current is I_{nom}, and is stated on the motor rating plate. It is entered in parameter **Pr45** as a percentage of the rated I_{pk} of the drive. I_{nom} can be given any value from 20% to 50% of I_{pk}. For example, if I_{pk} for the drive is 6.6A and I_{nom} for the motor is 3A, then

$$\textbf{Pr45} = \frac{I_{nom}}{I_{pk}} \times 100 = \frac{3}{6.6} \times 100 = 45.45\%$$

As the resolution of **Pr45** is 1(%), the value to be entered is 45 in this example.

This facility enables the user to select, as is often necessary in servo engineering, a drive with a rating considerably higher than that of the nominal current of the motor in order to achieve very high rates or acceleration, and to know with certainty that the drive can be programmed with the details essential to enable the system to operate correctly.

3 PROTECTION

The effect of **Pr42** on the operation of the drive is important. Up to and including the rated I_{nom} current, the motor can operate for indefinite time.

When an acceleration demand is made on a servo-motor the I_{nom} threshold is exceeded; the motor operates at I_{max}, which means that it is, in normal terms, overloaded, but this is not, for a servo-motor, considered to be an abnormal condition. Overload and overcurrent protection requires a summation of the instantaneous currents with respect to time — the energy delivered to the motor being determined by I^2t. The integration begins when the current exceeds the value of I_{nom}. To take account of the special needs of servo-systems the software is configured to act in the following way.

During a period of acceleration, if the I^2t integration reaches its limit but the actual current circulating in the motor is not greater than 100% of I_{pk}, current output is reduced to, and limited to, I_{nom} (but can become less, if the controlling reference is reduced for any reason). Thus, activation of the I^2t protection in the 'overload' situation does not stop the operation of the drive, but reduces the deliverable current until the value of accumulated energy falls below the I^2t threshold.

Current is in excess of 110% of I_{pk} — which would indicate an abnormal condition such as a short-circuit or earth fault in the motor circuit — causes the I^2t protection to inhibit the drive output completely, and to signal the fault (trip code **OC**).

The time factor in the I^2t integration is determined by the thermal time-constant (τ), of the motor which is a value particular to each different make, type and size of motor and is specified by the motor manufacturer (and will usually be found on the motor rating plate). It is entered directly as the value of **Pr55.**

During operation, the actual present value of I^2t can be interrogated through parameter **Pr80**, which gives an indication of I^2t as a percentage of the fully-integrated value (range 0 to 100) and offers the facility to study the degree of utilisation of the servo-system during the operating cycle.

CAUTION

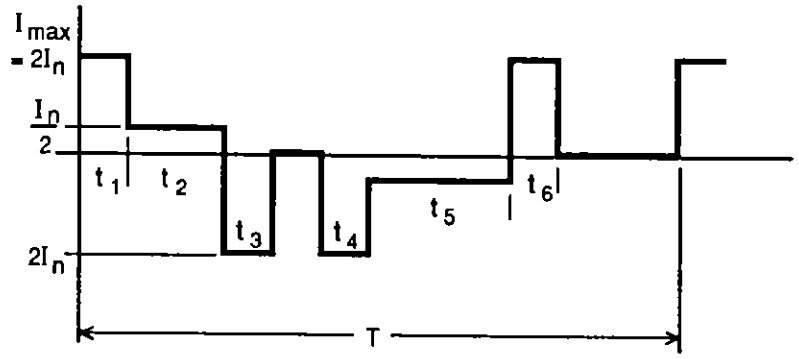
DS Series drives offer considerable flexibility in matching the exact requirements of a system by adjustment of **Pr42** and **Pr45**, but if the ratios selected for

$$\frac{I_{max}}{I_{pk}} \quad \text{or} \quad \frac{I_{nom}}{I_{pk}}$$

differ from what they would be if the nameplate values were used, consideration should be given to entering a different value of the motor thermal time-constant to compensate.

- By increasing the ratios, operating time will increase, or
- by decreasing the ratios, operating time will decrease.

If the operating time is greater than it otherwise would have been, compensation can be made by increasing the value entered in **Pr55**, or by decreasing the value is the time is less.



10 Typical duty cycle; calculation of I_{eff}.

4 ANALYSIS of I_{eff}

When the specifications of the mechanical system and of the duty cycle are known it is possible to evaluate the effective current I_{eff} to verify whether it exceeds I_{nom} at any part of the cycle, and to modify the duty cycle to avoid entering the I^2t integration zone. For example, a typical cycle is shown in Fig. 10, in which —

$$I_{eff} = \sqrt{\left(\frac{I_1^2 t_1 + I_2^2 t_2 + I_3^2 t_3 + I_4^2 t_4 + I_5^2 t_5 + I_6^2 t_6}{T} \right)}$$

To ensure that 'temperature ripple' does not cause the I^2t integrating region to be entered, I_{eff} must not exceed I_{nom}.

5 PID FUNCTION

The default values of the dynamic parameters (PID) are valid for typical servo-drive applications and it is generally recommended that the PID function should not be disturbed until the drive is commissioned and its behaviour during the normal duty cycle has been observed. These parameters are —

No	*Function*	*Default*
Pr13	System proportional gain	
	Range 0 to 255, resolution 1	30
Pr14	System derivative gain	
	Range 0 to 64, resolution 1	30
Pr15	System integral gain	
	Range 0 to 100, resolution 1	30

If after commissioning trials it is considered that some improvement could be made, please refer to the calibration procedures for these parameters in Section 6 of this chapter, page 6-9.

6 FULL-SCALE SPEED CALIBRATION

Typically, motion controllers match a speed reference signal of 8V to 9V with maximum speed, reserving a margin of 1V to 2V to cover tracking errors. DS Series drives recognise a 10V signal as maximum speed demand. Consequently, the full scale speed value entered in **Pr99** should be 10% to 20% greater than the maximum available input signal.

For example —

An application requires a maximum working speed of 2400rpm. The controller in use has 8V output corresponding with maximum speed, but with extension possible up to 10V.

1 If the value programmed into **Pr99** = 2400 corresponding to a 10V reference when the available maximum speed reference is 8V, the motor would turn at 1920rpm maximum.

For correct adjustment —

$$\mathbf{Pr99} = \frac{\text{Max } V_{ref} \times n_{max}}{\text{Controller } V_{ref}}$$

where, Max V_{ref} = the drive maximum input reference (10V)
n_{max} = the required maximum speed (2400rpm)
Controller V_{ref} = the output of the controller corresponding to maximum speed (8V)

then, $$\mathbf{Pr99} = \frac{10 \times 2400}{8}$$

2 Alternatively, for a more-accurate full speed calibration, the controller reference output signal should be extended to 10V, and a speed value chosen which is close to and above the required maximum speed (eg 3250 for a required maximum of 3200), The trim can then be used for final adjustment. The trim adjustment (-20%< trim< +20%) is located on the front panel of the drive between terminals B8 and B9, Fig. 5 page 4.2.

Any of the above values which require to be changed should be stored (procedure details are in Chapter 5 Section 2) or they will be lost when the drive is powered down and instead the default values will be applied at the next power up.]

6.4 Resolver Phasing

WARNING
The motor shaft must be uncoupled from the driven load during the process of resolver phasing. Set parameter **b02** = 0, and apply +24V to terminal B14.

Although the motor-resolver assemblies supplied with the drive are already phase-controlled, it may be necessary, if using an untested unit, to check the resolver phase control referred to the motor and to make adjustments.
Set **b49** =1. The motor will perform a series of rotations, each of approximately 20°, and all in the same direction until a whole revolution of 18 steps has been completed. If movements are not of equal amount, or not all in the same direction, the connections to the motor and the resolver should be inspected, and the process repeated.
The display will show the phase error between the motor and the resolver. Record the value displayed.
Select **Pr16** and enter a value equal to the sum of its present value and the value recorded at the end of the phase control procedure. As the range of **Pr16** is 0 to 2047, if the sum is <2047, set the values of the sum; if the sum is >2047, subtract 2047 and set the difference.

For example —
1 The value recorded at the end of phase control is 250.
The present value of **Pr16** is 1500
250 + 1500 = 1750
Programme **Pr16** = 1750
2 The value recorded at the end of phase control is 500.
The present value of **Pr16** is 2000
500 + 2000 = 2500
2500 - 2047 = 453
Programme **Pr16** = 453

6.5 Commissioning Trials

After the preliminary adjustments have been made to parameters as appropriate to the drive, physical verifications should be systematically made, after which the drive can safely be operated and it will be possible to determine —
- what alterations need to made to the parameters already set, and
- what additional settings need to be done to configure the drive correctly for the application.

Provision is made to select either analogue input or digital speed or torque reference. Refer to the diagrams in Chapter 11.

1 VERIFICATIONS

1 Make sure that all wiring terminals have been fully tightened on the drive terminal block A, and at the motor and the resolver.

2 DISCONNECT the control connections from terminals B9 through to B17 inclusive. The resolver connections B18 through to B25, not including B19, MUST be connected. (Terminal B19 is not internally connected, and has no use.)

3 If the drive is one of a multi-axis system, securely isolate all other drives in the system by removing the supply fuses or, if fuses are not used, by whatever secure isolation procedure is appropriate.

4 Power up the drive. The display will first show **Ux.xx** (or **Sx.xx** if special software has been supplied) and will then change to **rdY.**

5 If using the serial link, verify the correct programming of the transmission format characteristics (please refer to Chapter 10).

6 Unless the hold zero speed function is specifically required, disconnected terminal B6 and verify that **b18** = 0 (default value).

2 MOTOR FUNCTION TESTS

For the following tests it is recommended that the motor should be mechanically uncoupled, although it is not essential if the load is easy to rotate by hand.

1 Select parameter **Pr83**. Rotate the motor shaft by hand in a clockwise direction (looking at the shaft end of the motor). Observe that the displayed value of **Pr83** increments as the shaft is turned. Reverse the direction of rotation and observe that the value decrements. If the observed indications are otherwise, inspect the resolver connections.

2 Verify the phasing of the resolver. (This step is unnecessary if the resolver phasing procedure has already been performed, reference Section 6.3.) Set **b49** =1. Verify that the motor always runs in the same direction, by steps each corresponding to 20^{o} of rotation. If motion is seen to be irregular, inspect the resolver connections.

3 Restore the control connections to terminals B9 through to B17. If using a digital input reference (terminal B6), make it zero. If using an analogue input (terminals B9 and B10), set the reference to zero.

4 Enable the drive by applying a +24V signal at terminal B14. The motor will remain stopped in hold or, in the case of analogue reference it may rotate, but at low speed due to an offset in the reference generator.

5 Apply a reference — below 1V if analogue, or a low value such as 10% of maximum speed. Observe that the rotation of the motor is correct.

This completes the fundamental verification tests for the drive and motor. The procedure should be repeated for all other drives in a multi-axis system before beginning the working tests in automatic mode. Finally, the machine should be made to execute standard working cycles in normal operating conditions for a period of at least 15 minutes, during which each drive in the system should be interrogated —

- If **b33** = 0, at least one alarm condition exists, and further investigation is necessary;
- If **b89** =1, the drive has entered the I^2t region. The actual value of I^2t is displayed by **Pr80** as a percentage (fully-integrated value =100). It may be necessary to reconsider the setting of **Pr45** or the revision of the duty cycle to modify I_{eff} (refer to Fig. 10).

6.6 Calibrations

1 ZERO SPEED CALIBRATION (OFFSET)

The speed reference generator may sometimes have an offset, with the result that at zero reference the motor turns slowly. **Pr06** can be programmed to compensate. The value entered is the actual rpm of the motor at zero speed reference. The resolution of 0.1 permits precise setting of the compensating offset.

2 DYNAMIC CALIBRATIONS

Final calibration is performed with the motor coupled to its normal load.

In the majority of applications little change will be found necessary for most parameters after the preliminary setting have been made as in Section 3 of this chapter. If any change should be necessary, due for example, to a high load inertia (>3x motor inertia), the procedure is as follows.

NOTE

Calibration test involve movement of the load. Care must be taken to ensure that the motion does not over-ride limit switches.

1 — Preliminary Settings

Set **b07** = 0
b12 = 1
b18 = 0
Pr58 = maximum speed (= **Pr99**)
Pr99 = full-scale speed of the motor

1A — Digital Reference

PARAMETERS —

Set **b17** = 1
Pr00 = **Pr 58** + 5
Pr01 = **Pr 58** + 5
Pr02 = **Pr 58** + 5
Pr03 = **Pr 58** + 5
Pr19 = 25 (= 0.2Hz)
Pr21 = 1

TERMINALS —

Disconnect terminal B6, the Zero Speed or the Positioning command.

1B — Analogue Reference

PARAMETERS —

Set **b17** = 0

TERMINALS —

Disconnect terminal B6, the Zero Speed or the Positioning command.
Disconnect terminals B9 and B10 to isolate the reference.
Link terminals B9 and B11.

SIGNAL GENERATOR —

Programme the generator to deliver a square wave output, 4V amplitude (ie -2V to +2V), at 0.2Hz.

Connect the non-inverted side of the signal to terminal B10, and common to B11.

2 — Common Procedure

OSCILLOSCOPE —

Adjust both channels to a sensitivity of 1V per division, with a scan time of 20ms per division.

Attach probe A to terminal B16, and probe B to function generator output .

Attache probe earth to terminal B11 or B18 (0V common)

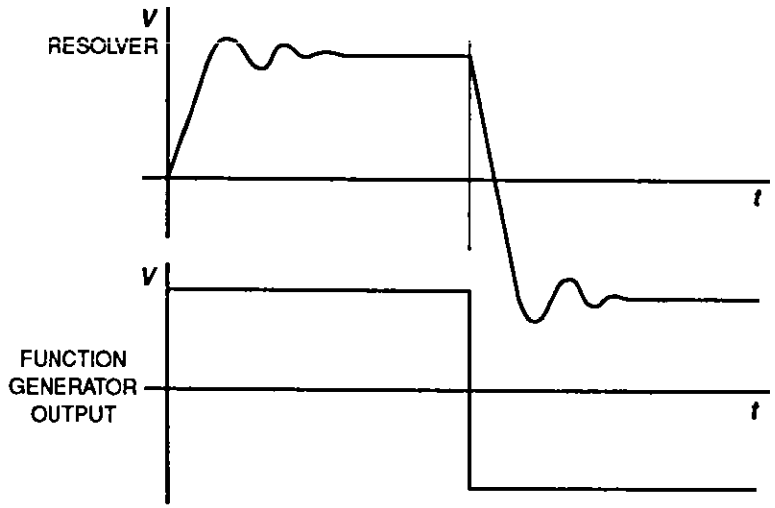
Select the Channel B trigger on the oscilloscope.

Analogue Reference

The signal frequency may be increased to reduce the stroke. The speed may be decreased by reducing the signal amplitude, but amplitude must be 1V minimum.

Digital Reference

Speed may be reduced by decreasing the programmed values of **Pr00**, **Pr01**, **Pr02**, **Pr03**, or the inversion frequency may be increased by decreasing the value of **Pr19**.



11 Proportional dynamic gain low.

7
Functional Structure

In reading this chapter it will be found helpful to study and refer to the Logic diagrams of the control system and the Mode Selector diagrams in Chapter 11.

7.1 Control Loops and Logic

This Section of the User's Guide explains the function of the control logic by treating the principal stages one by one, beginning with the speed reference input.

1 SPEED LOOP

1.1 Configuration as a Speed Controller

The input reference is to be applied to the speed loop, therefore **b06** = 0. There is a choice between analogue and digital reference. Selection is made by **b17** —

- **b17** = 0 selects analogue speed reference
- **b17** = 1 selects digital speed reference

Analogue

The analogue signal is applied between terminals B9 and B10. The source of the analogue signal may be affected by an offset. This, if present, can be corrected by **Pr06**.

Digital

Digital references are programmable into **Pr00**, **Pr01**, **Pr02** and **Pr03**, each of which may hold a different value. Three alternatives are provided as the means of selecting the required digital speed reference —

- by direct selection though **Pr20**,
- by coded (binary) inputs at terminals B4 and B5,
- by cyclic scanning of the four programmed references.

Any of the methods requires first that values are assigned to the four reference parameters. The range of the assigned values is determined by the full-scale value programmed in **Pr99**, which may be one of two ranges — either 200 to 3000rpm or 3200 to 6400rpm. The values assigned to **Pr00**, **Pr01**, **Pr02** and **Pr03** must be appropriate to the band selected for **Pr99**, for example if **Pr99** is 2500, the values for **Pr00** — **Pr03** must be in the -3000 — +3000.

DIRECT SELECTION of the digital reference is enabled by setting Pr21 = 0; the required reference value is applied by programming its number, **Pr00** etc, into **Pr20**.
CODED SELECTION is enabled by setting **Pr16** = 0 and **Pr21** = 2; the required parameters is then selected by input codes at the terminals as follows —

	Terminal	
	B4	*B5*
Pr00	0	0
Pr01	0	1
Pr02	1	0
Pr03	1	1

Selection by CYCLIC SCANNING is enabled by setting **Pr21** =1; the reference parameters will then be selected in sequence at intervals defined by the value programmed in **Pr19**.

MONITORING the input speed reference —
The analogue speed reference is not monitored at the input stage.
The active digital input is displayed by **Pr24**.
The source of selection for the digital reference is displayed by **Pr17**.
The status of the inputs at terminals B4 and B5 is displayed by **Pr18**.

1.2 Ramp Functions

Enable

The ramp functions can be excluded from the speed input entirely.
To enable, **b07** =1; to disable, **b07** = 0.
The ramp values are programmed by setting a time in milliseconds, which for each ramp is related to a change in speed of 1000rpm, thus the setting actually specifies the slope of the ramp. The gradients of all four ramps can be different. For further detail, please refer to Chapter 8 Section 1.

1.3 Post-ramp Functions

A speed reference, after modification by the ramp functions, is delivered to a summing point where the speed feedback is subtracted. The reference then becomes the speed error signal. This is further modified by the PID function, **Pr13**, **Pr14** and **Pr15**, and enters the current loop.

1.4 Stop Functions

The permutations of possible stop functions are as follows —

Sources

- Normal stop signal source either —
  digital input at terminal B6 (0V), or
  selection of **b18** =1

- Limit switch stop signal at terminals B4 and B5

A stop signal from any source has the effect of disabling the speed reference, and in effect imposing a zero speed reference to maintain dynamic control of the motor at rest ('stop-hold').

Stopping Configurations

Either source (as above) can be programmed to —

- stop and hold zero speed — with deceleration ramps,
- stop and hold zero speed — without deceleration ramps,

The normal stop function, but not the limit-switch stop, can alternatively be programmed to —

- stop and orientate to position — with deceleration ramps.

Programming

(In addition to ramps enable, and ramp values — refer to **b07**, **Pr09**, **Pr10**, **Pr11** and **Pr12**)
The programming facilities are as follows —

Normal stop sources
Both sources are active and are delivered to a logic OR which accepts either.

Normal stop with ramps
b53 = 0 and **b22** = 0
Normal stop without ramps
b53 = 0 and **b22** = 1
Normal stop with orientation
b53 =1 (orientation **Pr27**) with ramps
If the motor is at rest when an orientation signal is given, the shaft will rotate through the lesser of the alternative angles to the programmed position.

Limit switch stop source

Limit	*Terminal*	
switch	*B4*	*B5*
A	1	0
B	0	1

+24V = Logic 1 = STOP

Limit switch stop with ramps
b16 =1 and **b23** = 0
Limit switch stop without ramps
b16 =1 and **b23** = 1

2 CURRENT LOOP

2.1 Configuration for Current Reference

For the applications where a servo-motor is to be operated in a master/slave configuration, DS Series drives can be operated with a current reference instead of a speed reference.

The input reference is to be applied to the current loop, therefore **b06** =1. There is a choice between analogue and digital reference. Selection is made by **b08** —

- **b08** = 0 selects analogue current reference
- **b08** = 1 selects digital current reference

Analogue

The analogue signal is applied between terminals B9 and B10.

Digital

The digital reference is programmable into **Pr08**. The value entered ranges from -100 to +100, the maxima corresponding to the value of I_{max}, which is set as a percentage of the nameplate rating value I_{pk} of the drive. I_{max} is programmed in **Pr42**. For a full explanation of this parameter, please refer to Chapter 6 Section 3.

2.2 Current (torque) Limitation

The power stage of the drive is controlled by the current error signal from the summation point where the the current feedback from the motor is subtracted from the current reference. The current reference is either —

- the speed error signal after PID, or
- the external analogue current reference, or
- the internal digital current reference **Pr08**

and is subject to limitations before summation with the feedback. The limitations are —

- I2t, for overload protection. This is a value integrated in **Pr43** from the programmed current value Inom (**Pr45**) and the motor thermal time-constant (**Pr55**).
- Imax (**Pr42**), programmed to match the specification of the motor and the characteristics of the servo-system.

These two limitations are necessary for the correct and safe operation of the drive. Further explanation of the programming features associated with the values of I_{nom}, I_{max} and I_{pk} is given in the discussion of the essential preliminary setting of the drive, Chapter 6 Section 3.

Provision is made for an additional current-limit signal to be applied as required at terminal B1. This input is controlled by **b11** =1, which offers the alternative use of terminal B1 for an external trip signal.

Instantaneous values of current are shown in the following RO parameters —

- **Pr39** the value of the analogue current limit signal at terminal B1
- **Pr43** the current limit signal after the I^2t computation, as a percentage of I_{pk}
- **Pr41** the current reference threshold, corresponding the the least value among **Pr42**, **Pr43**, and **Pr39**
- **Pr40** the analogue value of the current reference; this can be made available at terminal B16 as the Clamped Current Demand

7.2 Most-used Configurations

As a Speed Controller

NOTE A maximum speed limit is programmable in **Pr58**. The drive is disabled if demand exceeds the programmed value.

Description	*Parameter*	*Setting*	*Default*
Analogue reference input	**b06**	0	0
	b17	0	0
Digital reference input	**b06**	0	0
	b17	1	0

As a Torque Controller

Description	*Parameter*	*Setting*	*Default*
Analogue torque reference input	**b06**	1	0
	b08	0	0
Digital torque reference input	**b06**	1	0
	b08	1	0

As a Speed Controller with Torque Limitation

Description	*Parameter*	*Setting*	*Default*
Digitally-limited torque			
in % of peak torque	**Pr42**	% value	100
Analogue-limited torque			
100% of peak current = 10V	**b11**	1	1

2 CURRENT LOOP

2.1 Configuration for Current Reference

For the applications where a servo-motor is to be operated in a master/slave configuration, DS Series drives can be operated with a current reference instead of a speed reference.

The input reference is to be applied to the current loop, therefore **b06** =1. There is a choice between analogue and digital reference. Selection is made by **b08** —

- **b08** = 0 selects analogue current reference
- **b08** = 1 selects digital current reference

Analogue

The analogue signal is applied between terminals B9 and B10.

Digital

The digital reference is programmable into **Pr08**. The value entered ranges from -100 to +100, the maxima corresponding to the value of I_{max}, which is set as a percentage of the nameplate rating value I_{pk} of the drive. I_{max} is programmed in **Pr42**. For a full explanation of this parameter, please refer to Chapter 6 Section 3.

2.2 Current (torque) Limitation

The power stage of the drive is controlled by the current error signal from the summation point where the the current feedback from the motor is subtracted from the current reference. The current reference is either —

- the speed error signal after PID, or
- the external analogue current reference, or
- the internal digital current reference **Pr08**

and is subject to limitations before summation with the feedback. The limitations are —

- I2t, for overload protection. This is a value integrated in **Pr43** from the programmed current value I_{nom} (**Pr45**) and the motor thermal time-constant (**Pr55**).
- I_{max} (**Pr42**), programmed to match the specification of the motor and the characteristics of the servo-system.

These two limitations are necessary for the correct and safe operation of the drive. Further explanation of the programming features associated with the values of I_{nom}, I_{max} and I_{pk} is given in the discussion of the essential preliminary setting of the drive, Chapter 6 Section 3.

Provision is made for an additional current-limit signal to be applied as required at terminal B1. This input is controlled by **b11** =1, which offers the alternative use of terminal B1 for an external trip signal.

Instantaneous values of current are shown in the following RO parameters —

- **Pr39** the value of the analogue current limit signal at terminal B1
- **Pr43** the current limit signal after the I^2t computation, as a percentage of I_{pk}
- **Pr41** the current reference threshold, corresponding the the least value among **Pr42**, **Pr43**, and **Pr39**
- **Pr40** the analogue value of the current reference; this can be made available at terminal B16 as the Clamped Current Demand

7.2 Most-used Configurations

As a Speed Controller

NOTE A maximum speed limit is programmable in **Pr58**. The drive is disabled if demand exceeds the programmed value.

Description	*Parameter*	*Setting*	*Default*
Analogue reference input	**b06**	0	0
	b17	0	0
Digital reference input	**b06**	0	0
	b17	1	0

As a Torque Controller

Description	*Parameter*	*Setting*	*Default*
Analogue torque reference input	**b06**	1	0
	b08	0	0
Digital torque reference input	**b06**	1	0
	b08	1	0

As a Speed Controller with Torque Limitation

Description	*Parameter*	*Setting*	*Default*
Digitally-limited torque			
in % of peak torque	**Pr42**	% value	100
Analogue-limited torque			
100% of peak current = 10V	**b11**	1	1

Ramp Definition

To activate ramp function b07 =1

Rotational sense when looking at output shaft end

Description	*Parameter*	*Range*	*Default*
Clockwise acceleration	**Pr09**	1-9999	200
Clockwise deceleration	**Pr11**	1-9999	200
Counter-clockwise acceleration	**Pr10**	1-9999	200
Counter-clockwise deceleration	**Pr12**	1-9999	200

7.3 Supplementary Adaptations

These adaptations comprise adjustments after which the module hardware is no longer the 'as-delivered' condition. Users are advised to record a note on the front of the module stating that a certain modification has been made. This removes the risk that a modified module, if temporarily removed from service, might later be assumed to be in standard condition.

1 EXTERNAL BRAKING RESISTOR

On the larger DS Series drives (DS420, DS600, DS750) there is provision on terminal block A to connect an external resistor for applications in which the size of the standard (internal) resistor is inadequate. This will be the case if the driven load has unusually high inertia and the shortest deceleration times are desired.

The external resistor is connected between terminals A9 and A10. Users are recommended to ensure that the following precautions are taken when installing an external resistor —

Warning

- IT IS ABSOLUTELY ESSENTIAL that the INTERNAL RESISTOR is DISCONNECTED to avoid overheating it and damaging the driving circuit.
- The external resistor should be sited so that the heat generated by it can not affect the drive.

2 RESOLUTION of the SIMULATED ENCODER

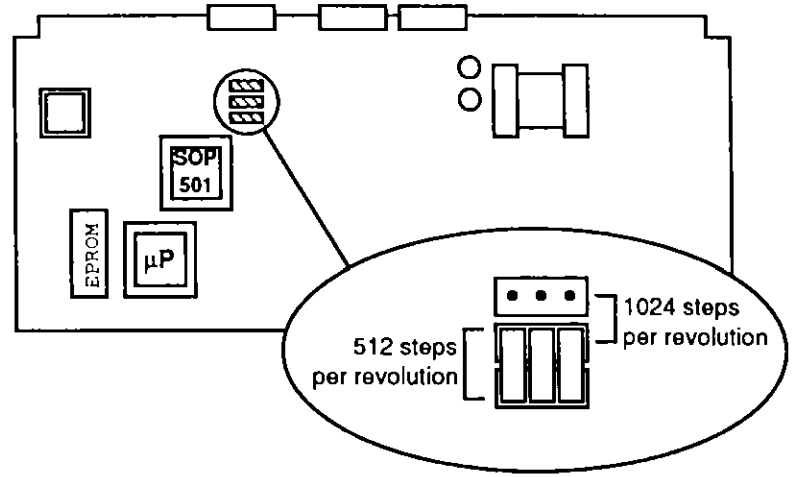
Two alternative resolutions are available —

1024 steps per revolution, or

512 steps per revolution.

Selection is made by adjusting the position of THREE links located on the signal processing card (Fig. 1). All three links must be together in one or other of the alternative positions. The locations of the links is illustrated in Fig. 15.

As delivered, the links are positioned for 512 steps per revolution.



15 Simulated-encoder — resolution selection. Location of selector links and positioning of links to select resolution.
DS Series drives are delivered with the links in the position shown.

7.4 Programmable Outputs

1 PROGRAMMABLE DIGITAL OUTPUTS

Selected by **Pr30** — output at terminal B7

Selected by **Pr31** — output at terminal B8

For both outputs, data is selectable from —

- **b38** direction of motor rotation
- **b41** motor status — running/stopped
- **b42** at-speed status
- **b48** speed loop saturation status
- **b84** overcurrent (alarm)
- **b89** I^2t integrating (alarm)
- **b91** overtemperature (pre-alarm)

2 PROGRAMMABLE ANALOGUE OUTPUTS

Terminal B16 output is configurable as follows —

b12 =1 Motor current

b12 = 0 Either —

b13 =1 Post-Ramp Speed Reference

Or —

b13 = 0 Then either —

b06 =1 Current reference, terminals B9 and B10 or **Pr08**

Or —

b6 = 0 Final Speed Reference

Terminal B17 output is the analogue tachogenerator signal.

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8
Parameters Descriptions

Parameters are listed in sequential order, numerical-value parameters first, followed by bit parameters. Numbering of the parameters is not wholly consecutive — there are some gaps where numbers are reserved for possible future use. Information about each parameter is presented in a consistent format —

- the symbol *P* indicates R/W parameters which are protected by the security code;
- number, whether read-or-write (R/W) or read-only (RO), and name;
- range (of numerical parameters only), and resolution;
- default value, and the status of that value (bit parameters only).

The basic data is followed , where appropriate, by an explanation of the purpose of the parameter and by reference to other associated parameters.

8.1 Numerical Parameters — descriptions

Pr00 R/W Digital Speed Reference *P*

Range	-3000 to 3000rpm	if 200 ≤ **Pr99** ≤ 3000
	-6000 to 6000rpm	if 3200 ≤ **Pr99** ≤ 6000
Default	0	Resolution 1rpm

Pr01 R/W Digital Speed Reference *P*

Range	-3000 to 3000rpm	if 200 ≤ **Pr99** ≤ 3000
	-6000 to 6000rpm	if 3200 ≤ **Pr99** ≤ 6000
Default	0	Resolution 1rpm

Pr02 R/W Digital Speed Reference *P*

Range	-3000 to 3000rpm	if 200 ≤ **Pr99** ≤ 3000
	-6000 to 6000rpm	if 3200 ≤ **Pr99** ≤ 6000
Default	0	Resolution 1rpm

Pr03 R/W Digital Speed Reference *P*

Range	-3000 to 3000rpm	if 200 ≤ **Pr99** ≤ 3000
	-6000 to 6000rpm	if 3200 ≤ **Pr99** ≤ 6000
Default	0	Resolution 1rpm

Parameters **Pr00**, **Pr01**, **Pr02**, and **Pr03** are programmable digital speed references. Their selection is controlled through **Pr17**, which receives its coding from the values of **Pr18**, **Pr19**, and **Pr20**, as selected by **b16** and **Pr21**.
Refer to **Pr17**, **Pr18**, **Pr19**, **Pr20**, **Pr21** and **b16**.

Pr04 RO Voltage level of DC Busbar
Range 0 to 1024V Resolution 4V

Pr05 RO Reserved for Internal Test

Pr06 R/W Analogue Reference Input Offset *P*
Range -50.0 to +50.0 Resolution 0.1
Default 0
Permits the user to apply a correction to any offset in the analogue input reference which otherwise would cause slow rotation of the motor with zero speed reference input.

Pr07 R/W Speed Loop Bandwidth Limit *P*
Range 1 to 5 Resolution 1
Default 1
Used to counteract mechanical resonance caused by the characteristics of the mechanical transmission or by high intertia of the driven load.

If	**Pr07** =	1	bandwidth limit is at	320Hz
	Pr07 =	2	bandwidth limit is at	160Hz
	Pr07 =	3	bandwidth limit is at	80Hz
	Pr07 =	4	bandwidth limit is at	40Hz
	Pr07 =	5	bandwidth limit is at	20Hz

Pr08 R/W Digital Current Reference *P*
Range -100.0% to +100.0% Resolution 1%
Default 0
User-programmable current reference, entered as a parcentage of I_{pk}. Polarity indicates the direction of motor rotation.

Pr09 R/W Acceleration Ramp Forward
Range 1 to 3000ms Resolution 1ms
Default 200ms
This is the slope of the ramp, measured in milliseconds per 1000rpm.

Pr10 R/W Acceleration Ramp Reverse
Range 1 to 3000ms Resolution 1ms
Default 200ms
This is the slope of the ramp, measured in milliseconds per 1000rpm.

Pr11 R/W Deceleration Ramp Forward
Range 1 to 3000ms Resolution 1ms
Default 200ms
This is the slope of the ramp, measured in milliseconds per 1000rpm.

Pr12 R/W Deceleration Ramp Reverse
Range 1 to 3000ms Resolution 1ms
Default 200ms
This is the slope of the ramp, measured in milliseconds per 1000rpm.

Pr13 R/W Proportional Gain *P*
Range 0 to 255 Resolution 1
Default 30

Pr14 R/W Derivative Gain *P*
Range 0 to 64 Resolution 1
Default 30

Pr15 R/W Integral Gain *P*
Range 0 to 100 Resolution 1
Default 30

Pr16 R/W Resolver Phasing *P*
Range 0 to 2047 Resolution 1
Default 0
This is the value of the resolver phase correction. Please refer to description of Resolver Phasing, Chapter 6 Section 4.

Pr17 RO Digital Reference
Range 0 to 3
Indicates the reference selected by **Pr21**.

Pr18 RO Digital Input Configuration (terminals B4 & B5)
Range 0 to 3
Signals at terminals B4 and B5 — <5V or open-circuit = 0
>5V = 1

Configuration of **Pr18** —

Terminal		
B4	*B5*	*Pr18*
0	0	0
0	1	1
1	0	2
1	1	3

Pr19 R/W Digital Reference Scan Time
Range 0.1 to 6000s Resolution 0.1
Default 10s
Please refer to the description in Chapter 7, Section 1.

Pr20 R/W Digital Reference Selector
Range 0, 1, 2, or 3 Resolution 1
Default 0
Directs **Pr17** to select from **Pr00**, **Pr01**, **Pr02**, or **Pr03**.
Pr20 = 0 selects the reference programmed into **Pr00**
Pr20 = 1 selects the reference programmed into **Pr01**
Pr20 = 2 selects the reference programmed into **Pr02**
Pr20 = 3 selects the reference programmed into **Pr03**

Pr21 R/W Digital Reference Selector Enable *P*
Range 0, 1, or 2 Resolution 1
Default 0
Pr21 = 0 enables the digital selector **Pr20**
Pr21 = 1 enables the time selector **Pr19**
Pr21 = 2 enables digital inputs if **b16** = 0

Pr22 R/W Drive Address *P*
Range 1 to 32 Resolution 1
Default 1
Required for all systems where the Serial Link is to be used, to permit communication with a selected drive.

Pr23 R/W Baud Rate *P*
Range (see below)
Default 9600
This parameter can be set only at the keypad, not through the Serial Link. Available values are —
300, 600, 1200, 2400, 4800, 9600, 19 200.
Adjust this parameter value to the Baud rate of the host computer.

Pr24 RO Digital Run Reference
Range ±6000rpm
Indicates the value of the selected digital reference in rpm at the start of the speed loop.

Pr25 R/W Security Code
Range 1 to 9999 Resolution 1
Default 0
When the drive is in 'as-delivered' condition, the value is the default value, and all parameters are accessible. When **Pr25** is set to any integer value >0, all R/W parameters (except those marked †) are protected. They can be read at any time, but cannot be changed unless the security procedure is performed after every power up. After power up, enter the correct security code; the protected parameters remain accessible to change until power down.
Please refer to Chapter 5 Section 3 and to **b00**.

Pr26 RO Drive Module Code
Indicates the module rating, 140 = module DS140 ...etc. This parameter is set during manufacture and is a fundamental part of the drive configuration. It is used to ensure that an already-programmed detachable keypad-display module is not united with a drive module of a different rating.

Pr27 R/W Shaft Orientation Function *P*
Range 0 to 2047 Resolution 1
Default 0
Resolver steps.
Determines the shaft orientation position as directed by either **b18** or the input at terminal B6, in con junction with **b53**.

Pr30 R/W Digital Output Selector 1
Range 0 to 6 Resolution 1
Default 0
Selects the parameter value available at terminal B7 —
Pr30 = 0 selects the I^2t alarm **b89**
Pr30 = 1 selects the temperature pre-alarm **b91**
Pr30 = 2 selects the current limit alarm **b84**
Pr30 = 3 selects the indication of present direction **b38**
Pr30 = 4 selects the indication of motor stopped **b41**
Pr30 = 5 selects the indication 'At Speed' **b42**
Pr30 = 6 selects the indication of speed loop saturation **b48**

Pr31 R/W Digital Output Selector 2
Range 0 to 6 Resolution 1
Default 1
Selects the parameter value available at terminal B8 —
Pr31 = 0 selects the I^2t alarm **b89**
Pr31 = 1 selects the temperature pre-alarm **b91**
Pr31 = 2 selects the current limit alarm **b84**
Pr31 = 3 selects the indication of present direction **b38**
Pr31 = 4 selects the indication of motor stopped **b41**
Pr31 = 5 selects the indication 'At Speed' **b42**
Pr31 = 6 selects the indication of speed loop saturation **b48**

Pr39 RO Analogue Current Input
Range -100 to +100 Resolution 1
Indicates the value of the analogue input as a percentage of reference voltage range, -10V to 10V.

Pr40 RO Clamped Current Demand
Range -100 to +100 Resolution 1
Indicates the value of the current after limitation at **Pr41**.

Pr41 RO Current Limitation Value
Range 0 to +100 Resolution 1
Indicates the value of the current corresponding to whichever is the least of —

- I^2t limit **Pr43**
- analogue limit **Pr39** if **b11** =1
- digital limit **Pr42**
- Reads 0 if drive diabled

Pr42 R/W Maximum Current Limit *P*
Range 0 to 100% Resolution 1
Default 100%
Expressed as a percentage —

$$\mathbf{Pr42} = \frac{I_{max}}{I_{pk}} \times 100$$

where I_{max} = the desired maximum current delivered to the motor

and I_{pk} = the rated maximum current of the drive

Pr43 RO I^2t Limit
Range 0 to +100 Resolution 1
Pr43 = 100 indicates current NOT in I^2t region
Pr43 = percentage of I_{pk} when current is in I^2t region

Pr45 R/W Nominal Current *P*
Range 20% to 50% Resolution 1
Default 50%
Expressed as a percentage —

$$\mathbf{Pr45} = \frac{I_{nom}}{I_{pk}} \times 100$$

where I_{nom} = the selected maximum continuous current delivered to the motor

and I_{pk} = the rated maximum current of the drive

Pr55 R/W Motor Thermal Time-constant, τ *P*
Range 0.4 to 10s Resolution 0.1
Default 7s
Set according to motor specification, in seconds.

Pr56 R/W Motor At-Speed Window — lower limit
Range ±Full Scale Speed Pr99 Resolution 1
Default 5 rpm
Refer also to **Pr57**, **b42** and **b96**.

Pr57 R/W Motor At-Speed Window — upper limit
Range ±Full Scale Speed Pr99 Resolution 1
Default 5 rpm
Refer also to **Pr56**, **b42** and **b96**.

Pr58 R/W Maximum Speed Limit *P*
Range 0 to 6500rpm Resolution 1
Default 3200rpm

Pr59 RO Motor Speed
Range ±6500rpm Resolution 1

Pr80 RO I^2t Level
Range 0 to 100% Resolution 0.1%
Displays values corresponding to the percentage set in **Pr42**. I^2t limitation is activated at 100%.

Pr83 RO Rotor Position
Range 0 to 2047 Resolution 1
Pr97 SOFTWARE ISSUE

Pr98 RO Last Alarm Store
Displays the code of the last alarm to have occurred. Non-volatile memory, unaffected by power down. Refer to Chapter 9 Section 1 for the list of code references.

Pr99 R/W Speed — Full Scale
Range 200 to 3000rpm Resolution 200rpm
Range 3200 to 6000rpm Resolution 400rpm
Default 3200rpm

8.2 Bit Parameters — descriptions

To address a bit parameter through the Serial Link, add the figure 1 to the front of the parameter number, eg to address **b05**, send 105; sending 05 addresses **Pr05**.

b00 R/W Enable Change of Security Code *P*
Default 0. disable
To enable the security code to be changed to any valid number. Refer to **Pr25**.

b01 R/W Recall Last Parameter Settings from EEPROM *P*
Default 0. not recall
Enables the user, while making changes and before storing the changes in EEPROM, to return to the last-written customised values. Compare with the action of **b05**.

b02 R/W Drive Enable
Default 1. enable
0 = Drive disable
1 = Drive enable. Refer also to terminal B14

b03 R/W Alarm Reset
Default 0. not reset
Accepts and cancels any alarm or trip, and updates the Last Alarm Store. Refer to **Pr98**.
NOTE — DISABLE the drive before RESET — **b02** = 0

b04 RO Drive Enable Status
b04 = 0, indicates drive disabled (by **b02** = 0, alarm, or terminal B14)
b04 = 1, indicates drive enabled

b05 R/W Recall Default Values from EPROM *P*
Default 0. not recall
Recalls the default values of all parameters from EPROM and enters them in RAM for immediate application. After this action, the RAM values are active but not saved, and after power-off power -on will be replaced by the previous settings in EEPROM unless saved. Default values are stored permanently in EPROM and always available for recall. Compare with the action of **b01**.

b06 R/W Reference Selector *P*
Default 0. speed loop
Refer also to **b08**.
b06 = 0, reference is the speed loop output
b06 = 1, current reference selected, either analogue or digital

Warning
b06 may be changed only when the drive is disabled and the motor stopped.

b07 R/W Enable Ramps *P*
Default 0. disable
Note that the default status is ramps disabled. Set **b07** =1 to enable.

b08 R/W Current Reference Mode Selector *P*
Default 0. analogue
Refer also to **b06**.
b08 = 0, analogue input
b08 = 1, digital input

b09 RO Digital Stop Function Status
Indicates the stop level present on the digital input at terminal B6.
If input at terminal B6 = 0V selection by software only. Refer to **b18**
If input at terminal B6 = 24V and **b53** = 1, function stop in Position Control Mode
If input at terminal B6 = 24V and **b53** = 0 and **b22** = 0, hold zero speed, without ramps
If input at terminal B6 = 24V and **b53** = 0 and **b22** = 1, hold zero speed, with ramps
Refer to **b18**.

b10 RO Digital Enable Value
Indicates the digital input value at terminal B14.
b10 = 0, 0V = not enabled
b10 = 1, 24V = enabled

b11 R/W Current Limit Selector *P*
Default 0. maximum current
Selects the current limit.
b11 = 0, I_{max}
b11 = 1, value of analogue input at terminal B1

b12 R/W Current Signal Selector
Default 0. refer to **b13**
Selects the current signal output available at terminal B16.
b12 = 0, refer to **b13**
b12 = 1, I_{motor}

b13 R/W Current Signal Selector
Default 0. clamped current demand **Pr40**
Selects the current signal source when **b12** = 0.
b13 = 0, Clamped current demand **Pr40**
b13 = 1, Post-ramp reference

b16 R/W Digital Speed Reference Selector *P*
Default 0
Selects the application of the digital signal inputs at terminals B4 and B5.
b16 = 0, and **Pr21** = 2 select digital speed reference
b16 = 1, digital inputs assume the function of limit switches

b17 R/W Speed Reference Input Selector *P*
Default 0. analogue
Selects analogue or digital speed reference at terminals B4 and B5.
b17 = 0, select analogue speed reference
b17 = 1, select digital speed reference

b18 R/W Digital Stop Selector
Default 0. digital
Selects the stop function without input at terminal B6.
b18 = 0, Function enabled by hardware only, refer to **b09** *(NORMAL)
b18 = 1, if **b53** = 1 stop with ramp to position and hold
b18 = 1, if **b53** = 0 and **b22** = 0 stop and hold , without ramps
b18 = 1, if **b53** = 0 and **b22** = 1 stop and hold , with ramps
Refer also to **b07**, **b09**, **b23**.

b21 R/W BCC Enable *P*
Default 1. enabled
b21 = 0, BCC disabled
b21 = 1, BCC enabled

b22 R/W Ramp-to-Stop Function
Default 1. with ramps
Stop and hold with or without ramps.
b22 = 0, without ramps
b22 = 1, with ramps

b23 R/W Limit Switch Ramp Function
Default 1. with ramps
Stop and hold with or without ramps.
b23 = 0, without ramps
b23 = 1, with ramps

b33 RO Alarm Status
b33 = 0, at least one alarm is active
b33 = 1, no alarm active

b38 RO Direction of Motor Rotation
Direction described when looking at motor drive shaft end.
b38 = 0, reverse = counterclockwise
b38 = 1, forward = clockwise

b41 RO Zero Speed Status
b41 = 0, motor not at zero speed
b41 = 1, motor at zero speed

b42 RO At-speed Status
b42 = 0, not at speed — motor speed is outside the range defined by **Pr56** and **Pr57**.
b42 = 1, at speed — motor speed is within the range defined by **Pr56** and **Pr57**.
Refer also to **Pr56**, **Pr57** and **b96**.

b48 RO Speed Loop Saturation Status
Saturation indicator of the speed loop when used with frequency/sign input
b48 = 0, speed loop in linear area
b48 = 1, speed loop saturated

b49 R/W Resolver Phasing
Default 0. inactive
b49 = 1, resolver phasing enabled.
Please also refer to Chapter 6 Section 4 and **Pr16**.

b50 R/W Display Return Function
Default 0
b50 = 0, after 8s approx. without a keystroke, display defaults either to **rdY** or speed value in rpm
b50 = 1, maintains the value of the last parameter to have been selected

b51 R/W Serial Link Data Format *P*
Default 0
b51 = 0, 8 data bits, no parity
b51 = 1, 7 data bits, even parity
NOTE This parameter can be adjusted only at the keypad, not through the serial link.

b52 R/W Serial Link Mode *P*
Default 0
b52 = 0, ANSI standard
b52 = 1, Terminal mode

b53 R/W Digital Stop Mode Selector *P*
Default 0
- **b53** = 0, Stop and hold
- **b53** = 1, Orientate, and hold

b55 RO External Trip Alarm
- **b55** = 0, No external trip
- **b55** = 1, External trip active

b56 R/W External Trip Enable *P*
Default 0
- **b56** = 0, trip disabled
- **b56** = 1, trip enabled

b81 RO Digital Output - short circuit
- **b81** = 0, circuit normal
- **b81** = 1, short circuit present

24V RAIL

b82 RO Digital Output - dc overvoltage
- **b82** = 0, voltage below permitted max (<840V)
- **b82** = 1, voltage above permitted max (>840V)

b83 RO Digital Output - dc undervoltage
- **b83** = 0, voltage above permitted min (>400V)
- **b83** = 1, voltage below permitted min (<400V)

b84 RO Digital Output - overcurrent
- **b84** = 0, current below the set limit
- **b84** = 1, current exceeding 110%I_{pk}

b85 RO Digital Output - overtemperature
- **b85** = 0, heat sink temperature below permitted max.
- **b85** = 1, heat sink temperature above permitted max.

b86 RO Digital Output - resolver fault
- **b86** = 0, no fault
- **b86** = 1, fault

b87 RO Digital Output - overspeed trip
- **b87** = 0, speed within limits
- **b87** = 1, speed>**Pr58**

b89 RO Digital Output - I^2t integrating
- **b89** = 0, drive not within I^2t zone
- **b89** = 1, I^2t limitation

b91 RO Digital Output - overtemperature pre-alarm
- **b91** = 0, heat sink temperature <75°C
- **b91** = 1, heat sink temperature >75°C

b96 R/W At-speed relative/absolute
Default 1, relative
Defines the meaning of the signal given by the 'At-speed' Status **b42**.
- **b96** = 1 (relative) relates the At-speed Status (**b42**) signal to the Speed Reference input, so that **b42** = 1 (At speed) when —
  (*Reference* - **Pr56**) < (Actual motor speed) < (*Reference* + **Pr57**).
- **b96** = 0 (absolute) makes the At-speed Status (**b42**) signal operate according to the absolute values set in **Pr56** and **Pr57**, so that **b42** = 1 (At speed) when —
  Pr56 < (Actual motor speed) < **Pr57**.
  - **b96** = 0, absolute
  - **b96** = 1, relative

  Refer also to **Pr56**, **Pr57** and **b42**.

b99 R/W Save RAM to EEPROM
Default 0, not save
Saves to EEPROM the new value of any parameter changed since the last power-on.
- **b99** = 0, no action
- **b99** = 1, save parameters from RAM to EEPROM

NOTE This function may be used only when the drive is disabled and the motor stopped. Setting **b99** =1 will also save the present value of **b02**, and this value will be used at the next power up. Software disable of the drive before saving will set **b02** = 0, so that at next power up the drive will be disabled. If automatic enable is required at next power up, **b02** must retain the value =1, which means that a hardware disable must be used before saving.

8.3 Summary of Default Values

Numerical Parameters (R/W)

	Parameter	Default	Units	Name
P	Pr00	0	rpm	Digital speed reference
P	Pr01	0	rpm	Digital speed reference
P	Pr02	0	rpm	Digital speed reference
P	Pr03	0	rpm	Digital speed reference
P	Pr06	0	% ref.	Analogue reference input offset
P	Pr08	0	% ref.	Digital current reference
	Pr09	200	ms	Forward acceleration ramp
	Pr10	200	ms	Reverse acceleration ramp
	Pr11	200	ms	Forward deceleration ramp
	Pr12	200	ms	Reverse deceleration ramp
P	Pr13	60	-	Proportional gain
P	Pr14	10	-	Derivative gain
P	Pr15	25	-	Integral gain
P	Pr16	0	-	Resolver phasing
	Pr19	10	s	Digital reference scan time
	Pr20	0	-	Digital reference selector
P	Pr21	0	-	Digital reference selector enable
P	Pr22	1	-	Drive address
P	Pr23	9600	-	Baud rate
	Pr25	0	-	Security code
P	Pr27	0	-	Shaft orientation function
	Pr30	0	-	Digital output selector 1
	Pr31	1	-	Digital output selector 2
P	Pr42	100	% I_{pk}	Maximum current limit
P	Pr45	50	% I_{pk}	Nominal current
P	Pr55	2	sec	Motor thermal time-constant τ
	Pr56	5	rpm	Motor at-speed window — lower limit
	Pr57	5	rpm	Motor at-speed window — upper limit
P	Pr58	3200	rpm	Maximum speed limit
	Pr99	3200	rpm	Speed — full scale

Bit Parameters (R/W)

	Parameter	Default	Effect	Name
P	b00	0	disable	Enable change of security code
P	b01	0	not	Recall parameter settings from EEPROM
	b02	1	enable	Drive enable
	b03	0	not	Alarm reset
P	b05	0	not	**Recall default values** from EPROM
P	b06	0	speed	Reference selector
P	b07	1	enable	Enable ramps
P	b08	0	analogue	Current reference mode selector
P	b11	0	delimit	Current limit selector
	b12	1	(b13)	Current signal selector
	b13	0	TPRC	Current signal selector
P	b16	1	limit sw.	Digital input selector
P	b17	0	analogue	Speed reference input selector
	b18	0	digital	Digital stop selector
P	b21	1	enable	BCC enable
	b22	1	enable	Ramp-to-stop function
	b23	1	with	Limit switch ramp function
	b49	0	inactive	Resolver phasing
	b50	0	return	Display return function
P	b51	0	8-bit	Serial link data format (parity)
P	b52	0	ANSI	Serial link mode
P	b53	0	0 speed	Digital input mode selector
P	b56	1	enable	External trip enable
	b96	1	relative	At-speed relative or absolute
	b99	0	not	Save Working Table to EEPROM

8.4 Indexes of Parameters

NUMERICAL PARAMETERS

BIT PARAMETERS

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9 Diagnostic Procedures

All read-only (RO) parameters are software 'test points', enabling the user to monitor all significant functions of the drive for the purpose of diagnosis. RO parameters are identified in Logic Diagrams (Chapter 11) by the diamond box.

9.1 Alarm and Trip Codes

Particular malfunctions lead to the automatic display at the keypad of a code to identify the malfunction. Through the serial link, trip codes are interrogated by the bit-flags. All possible codes are listed below.

CODE		
Display	*Ser. Comm.*	*Malfunction*
OU	1	Overvoltage. The dc busbar voltage has exceeded the maximum permitted level.
UU	2	Undervoltage. The dc busbar voltage has fallen below the minimum permitted level.
OC	3	Overcurrent. Current has exceeded 110% of I_{pk}.
th	4	Overtemperature. Heat sink temperature exceeds the maximum permitted level (95°C).
rb	5	Resolver null signal. May also indicate wrong connections, or a wiring failure.
It	6	Drive is operating in the I^2t region. If the integration times out, current output will be temporarily limited to I_{nom} (output will not be inhibited altogether).
PA	7	Temperature pre-alarm. Heat sink temperature close to limit.
OS	8	Overspeed.
SC	9	Short-circuit fault. Reset by power-off power-on.
Et	10	External trip.
d0I	11	Drive Operating Incorrectly. Fault may be cleared by power-off and power-on. If not, please consult the supplier of the drive.

9.2 Fault Finding

Conditions	*Causes*	*Actions*
At power up the hardware is enabled but the motor is disabled.	**b02** = 0	Set **b02** =1. Refer to the note, Ch.7, **Pr99**
Analogue speed reference ≠0 but motor does not turn and is in torque.	1 Hold-zero-speed function active. 2 Digital ref. selected.	Check that term. B4 = 0V *and* that **b18** = 0. Check that **b17** = 0.
Analogue speed reference varies but motor rotates at constant speed.	Digital ref. selected.	Check that **b17** = 0.
Motor speed changes with anal. ref. change, but speed and ref. do not correspond.	Torque control selected.	Check that **b06** = 0.
At 'enable drive', mot- is in torque, max. current, and enters I^2t region.	Faulty connections.	Check wiring, especially for inverted phases.
At 'enable drive' and with a speed ref., motor at standstill but also freely rotatable.	No current in motor.	Check that current limit (either anal. or digital) ≠ 0. (Refer to **b11** or **Pr42**, **Pr43** and **Pr45**.

Conditions	*Causes*	*Actions*
Communication with remote terminal not possible.	Serial comms. programming error.	Check Baud rates and data formats correspond. Check polarity of wiring connections.

	ASCII Hex	CTRL CHAR
EOT	$04	^D
ENQ	$05	^E
STX	$02	^B
ETX	$03	^C
CR	$0D	^M
NAK	$15	
ACK	$06	^F
BS	$08	^H
>	$3E	>
<	$3C	<
LF	$0A	^J
ESC	$1B	ESC ^Z
=	$3D	=

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10
Serial Communications

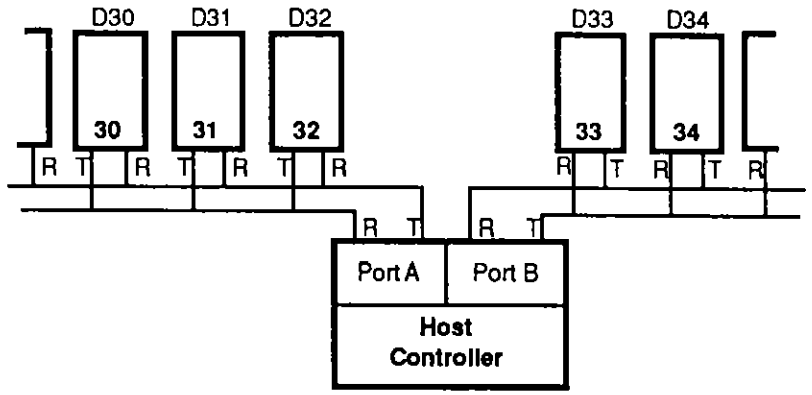
In reading this chapter it will be found helpful to refer to diagrams S1 and S2 in Chapter 11.

The serial interface allows direct connection between DS Series servodrives and a remote host computer or programmable logic controller (plc). The host can both control and monitor the servodrive.

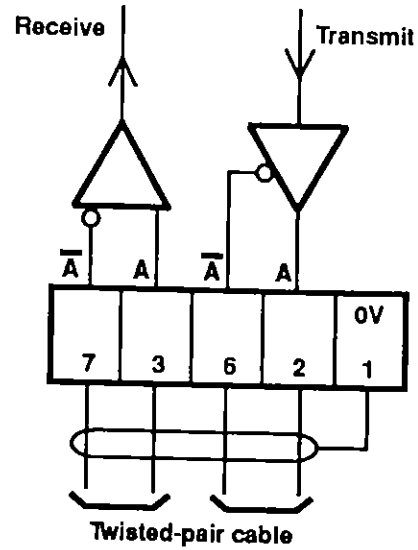
Two types of communication protocol can be used. The more complex complies with ANSI x3.28-2.5-A4 and, for all normal industrial operations, is recommended for its reliability. The second, known as Terminal Mode, is simpler and may be more convenient to use during a commissioning period. Terminal mode is explained in the final paragraph of this chapter.

RS485 and RS232C Connections

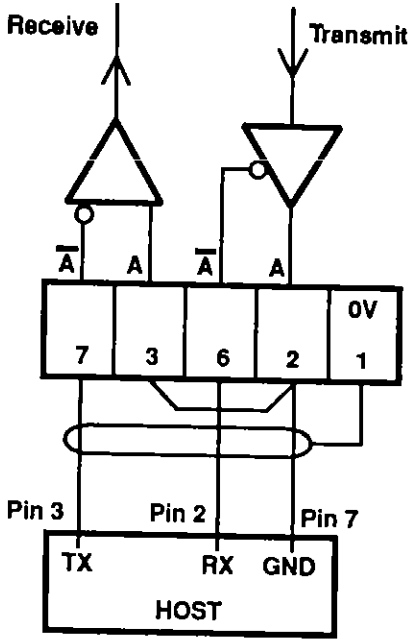
RS485 full duplex four-wire connection allows a multi-drop links to a maximum of 32 servodrives, Fig. 16. The maximum permissible cable length for each link is 1200m. RS485 is a differential link and ensures a high level of immunity to noise. It also withstands high common-mode rejection rates.



16 Serial address. Unique identity code for up to 32 drives per communications port at the host.



17 RS485 or RS422 serial communications link connections.



18 Connections for RS232 link.

If it is necessary to use the RS232C link it is recommended that adaptors should be used so as to exploit the advantages of RS485 as much as possible. RS232C links should be as short as possible.

Transmission Format

The ANSI protocol defines the format in which messages are transmitted and returned. It also makes provision for two different formats for interrogation (reading data) and for command (writing data). A message is made up of a number of characters. Typically, a character consists of 10 bits, as follows —

Either —

- One start bit, which is always logic 0
- 7 data bits
- One parity bit

Or —

- 8 data bits
- One stop bit, which is always logic 1

If a parity bit is required, a DS Series drive provides for even parity. Character length and parity control are programmed by **b51**.

Baud Rate

DS Series drives can be programmed to operate at one of seven of the Baud rates most commonly used in industrial communications. The Baud rate of each servodrive must be selected to correspond with that of the host. Baud rate is selected by **Pr23.**

INTERROGATE THE DRIVE — 'Read Data'

Format

The reading command consists of a maximum of 9 characters, but may use fewer. The format must be correct for the command to be successful. The format is constructed of a number of characters in a set sequence, thus —

| EOT | Address | Parameter | ENQ |

EOT is an (ASCII) character employed to initialise the message and to alert the receiver that a message is to follow. The equivalent in hexadecimal (hex) is 04.

Address

The address identifies the servodrive module whose status is to be interrogated. An address is usually required for any kind of message, with the exception that it is sometimes required to give an executive command simultaneously to all drives in a chain, in which case a special code is used. The address of every drive in a chain is a two-digit number unique to that drive in that chain, and is assigned during the commissioning of the system. For the purposes of communications security, the

address is always sent twice — four characters being transmitted. Thus, if the assigned address of a drive is 13, the characters actually transmitted as the address would be —

| 1 | 1 | 3 | 3 |

Parameter

The parameter identifies which item of data the drive is to send back, and is transmitted as a maximum of three characters.

Pr parameters are identified by a two-digit number. Thus for **Pr05**, the characters will be —

0 5

Bit parameters, having the same numerical range, 00 to 99, as the Pr parameters, are distinguished in serial communications by an initial figure 1. Thus for **b05**, the characters will be —

1 0 5

ENQ is an (ASCII) character employed to terminate the message and to instruct the receiver that the message is complete and to format a reply. The equivalent hex character is 05.

Drive reply to interrogation

The drive will reply with a message in the following format —

| STX | Parameter | Data | ETX | BCC |

STX is an (ASCII) character employed to inform the host that a response message is starting. The equivalent hex character is 02.

Parameter

For confirmation, the message identifies the parameter to which the following data relates. The same three-figure format is used.

Data

Six characters are available for the data. The first character contains, where appropriate, the polarity, plus or minus, of the data. Where polarity is not significant, and for bit parameters, the first character is blank (20 hex). The first character has the function of permitting the field of the data to be of any length up to the maximum, thus avoiding the necessity of sending a total of six characters when the data consists of less, as it frequently may. **ETX** indicates that the data is complete.

BCC (if enabled — refer to **b21**). The purpose of the BCC is to enable the host to verify the integrity of the transmitted information. If the function is disabled, the BCC calculation is replaced by the ASCII character CR (0D hex).

When the BCC is enabled, its field includes a single character calculated from the binary values of the Parameter number, the Data, and the end character. The calculation is an 'exclusive-or' (XOR). If the result of the calculation is less than 20 (decimal), the binary equivalent of 20 is added. This is because characters in the ASCII table in the (decimal) range 0 to 20 are exclusively used for control.

Quick Keystrokes

To save occupation time, certain data can be acquired, after the first enquiry command, by the following means —

Repeat last response

If the host sends NAK (15 hex), the drive will repeat the data for the same parameter. This is a quick way of observing a changing situation, since the drive, in repeating the response, is always sending updated information.

Read next parameter

The data for the parameter with the next higher number can be acquired simply by sending ACK (06 hex).

Read previous parameter

The data for the parameter with the next lower number can be acquired simply by sending BS (08 hex).

Error

If any feature of a message to the drive does not conform to format, or contains parameter values which are out of range, or which are otherwise improper — such as parameter address 203 for example — the drive will respond NAK. If this occurs, check the formulation of the message.

INSTRUCT THE DRIVE — 'Write Data'

Data written to a drive controls its functioning. A plc or a computer is thus in complete and constant control of each drive in a chain. Complex sequences can be performed under precise control, and with full access for data acquisition. The writing command consists of 17 characters in the following format —

| EOT | Address | STX | Parameter | Data | ETX |

to which may be added a BCC, if required (enabled by **b21**).

EOT — as for Read messages.

Address — as for Read messages.

STX — as for Read messages, STX instructs the drive that the significant part of the message or command is about to start.

Parameter — as for Read messages.

Data For Write messages, up to 6 characters maximum are permissible for the data relating to the parameter. The first character is the polarity, plus or minus, but if the parameter is one for which polarity is not significant, this character is a blank (20 hex). The first character has the function of permitting the field of the data to be of any length up to the maximum, thus avoiding the necessity of sending a total of six characters when the data consists of less, as it frequently may.

If the data is written to a greater resolution that that admitted by the drive, it is rounded off to the next higher value.

If the data is written to a value outside the permitted range for that parameter, the drive will respond NAK.

ETX — as for Read messages.

BCC — as for Read messages.

Other parameters — same drive

After the first complete command as above, further commands may be transmitted to the same drive by omitting EOT and/or the Address.

TERMINAL MODE

Terminal mode uses a simplified protocol —

| EOT | Address | CR |

For example, for drive whose address is 02, if the selection string sent is —

| EOT | 0022 | CR |

the drive will respond with

02 >

The computer will remain in open communication with this drive until a different selection string is sent.

To READ, send

P param. number = CR

For example, if it is required to know the value of parameter 24, the message is —

P 24 = CR

For **bit** parameter **b24**, the message would be —

P 124 = CR

To WRITE, the string is composed of the same characters but with the new value inserted after the = sign, thus —

P 24 = new value CR

Quick Keystrokes

ESC resets the current command line, clearing it of entered information

= Requests a repeat of the data for the parameter last addressed

> Requests the data for the parameter of next higher number

< Requests the data for the parameter of next lower number

Error

Plain language error messages are returned in Terminal Mode as follows —

SYNTAX ERROR	Message string does not comply with format
PARAMETER NOT RECOGNISED	A number has been given in the Address field which does not apply to any parameter
VALUE OUT OF RANGE	Value sent is above or below the maximum or minimum values permissible for the parameter addressed
TOO MANY CHARACTERS	20 characters is the maximum permitted in Terminal Mode
READ ONLY PARAMETER	An attempt has been made to write to a RO parameter

SERIAL COMMUNICATIONS PARAMETERS

P = Parameter protected by Security Code

P Pr22 R/W Drive Address
Range 1 to 32 Resolution 1
Default 1
Required for all systems where the Serial Link is to be used, to permit communication with a selected drive.

P Pr23 R/W Baud Rate
Range (see below)
Default 9600
This parameter can be set only at the keypad, not through the Serial Link. The range of available values is —
300, 600, 1200, 2400, 4800, 9600, 19 200.
Adjust this parameter value to the Baud rate of the host computer.

P b21 R/W BCC Enable
Default 1, enabled
b21 = 0, BCC disabled
b21 = 1, BCC enabled

P b51 R/W Serial Link Data Format
Default 0
b51 = 0, 8 data bits, no parity
b51 = 1, 7 data bits, even parity
NOTE This parameter can be adjusted only at the keypad, not through the serial link.

P b52 R/W Serial Link Mode
Default 0
b52 = 0, ANSI standard
b52 = 1, Terminal mode

11 Logic Diagrams

CONTROL LOGIC DIAGRAMS

Bit parameters are shown in DEFAULT status in control logic diagrams.

L1 Speed loop input references.

L2 Speed loop — stopping modes and final speed reference.

L3 Current loop. Clamped current demand.

L4 Final current demand. Current and speed feedback.

L5 Programmable inputs.

L6 Programmable outputs.

L7 Status and alarm outputs.

MODE SELECTOR DIAGRAMS

M1 Digital speed reference or limit switch function.

M2 Speed control, analogue or digital, or current control.

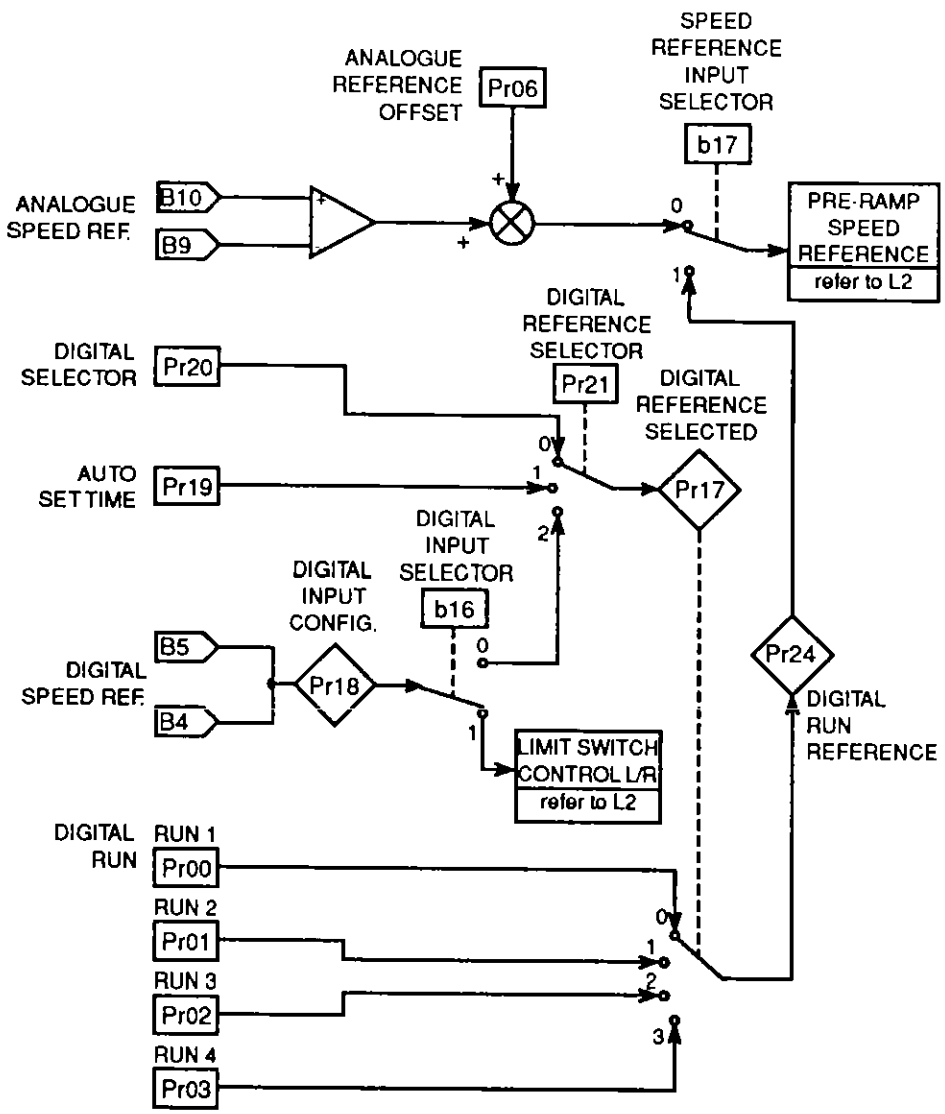
M3 Stop mode — stop-and-hold or stop-and-orientate.

M4 Signal output at terminal B16.

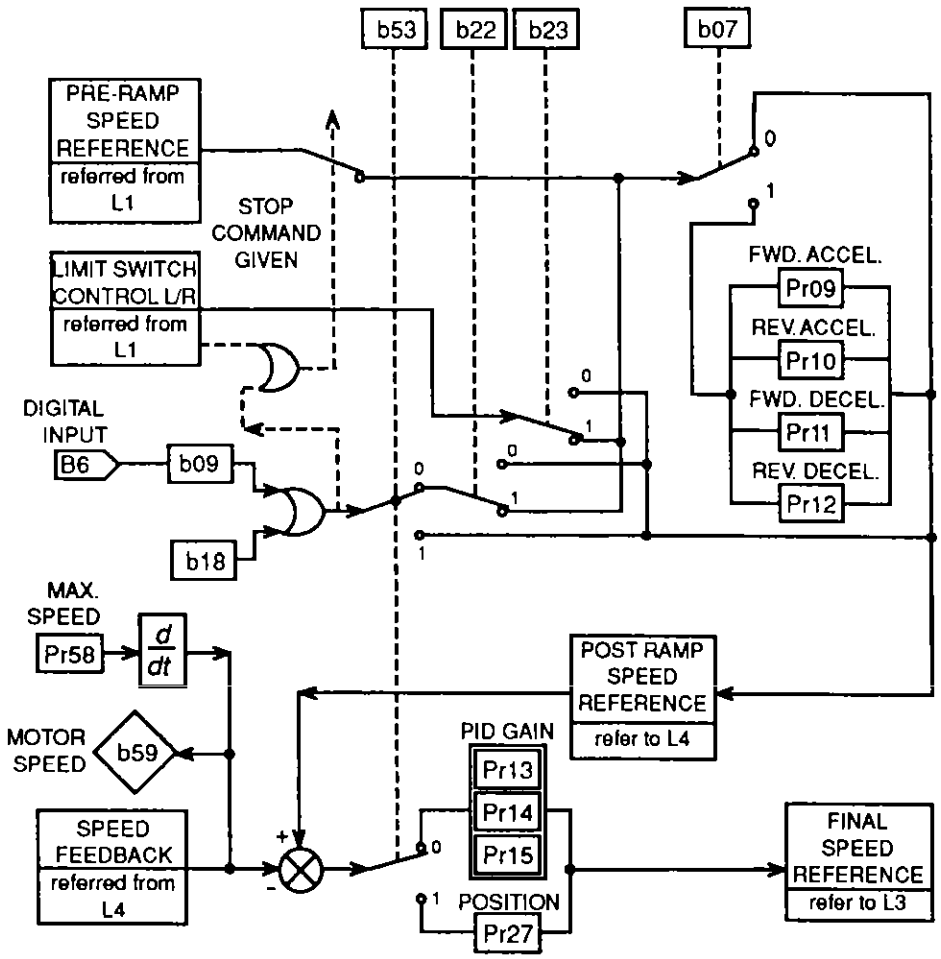
SERIAL COMMUNICATIONS PROCEDURES

S1 To read a parameter value.

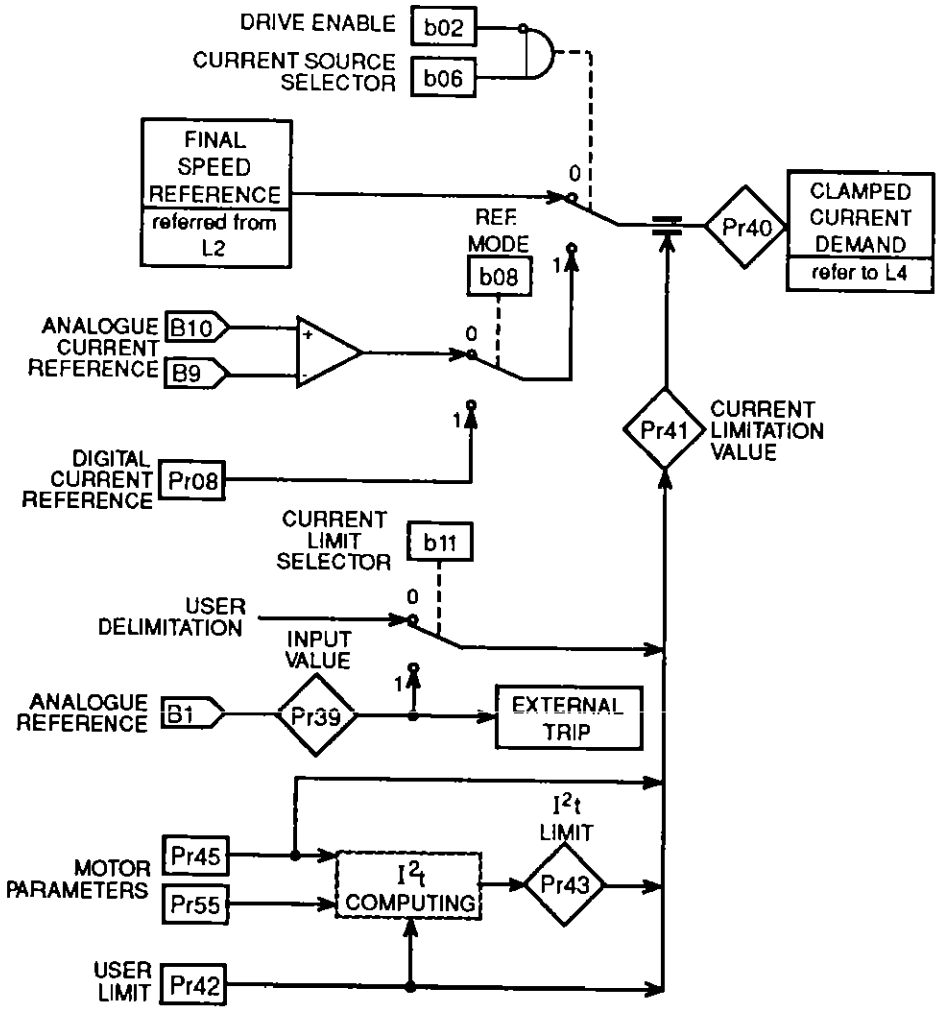
S2 To write (change) a parameter value.



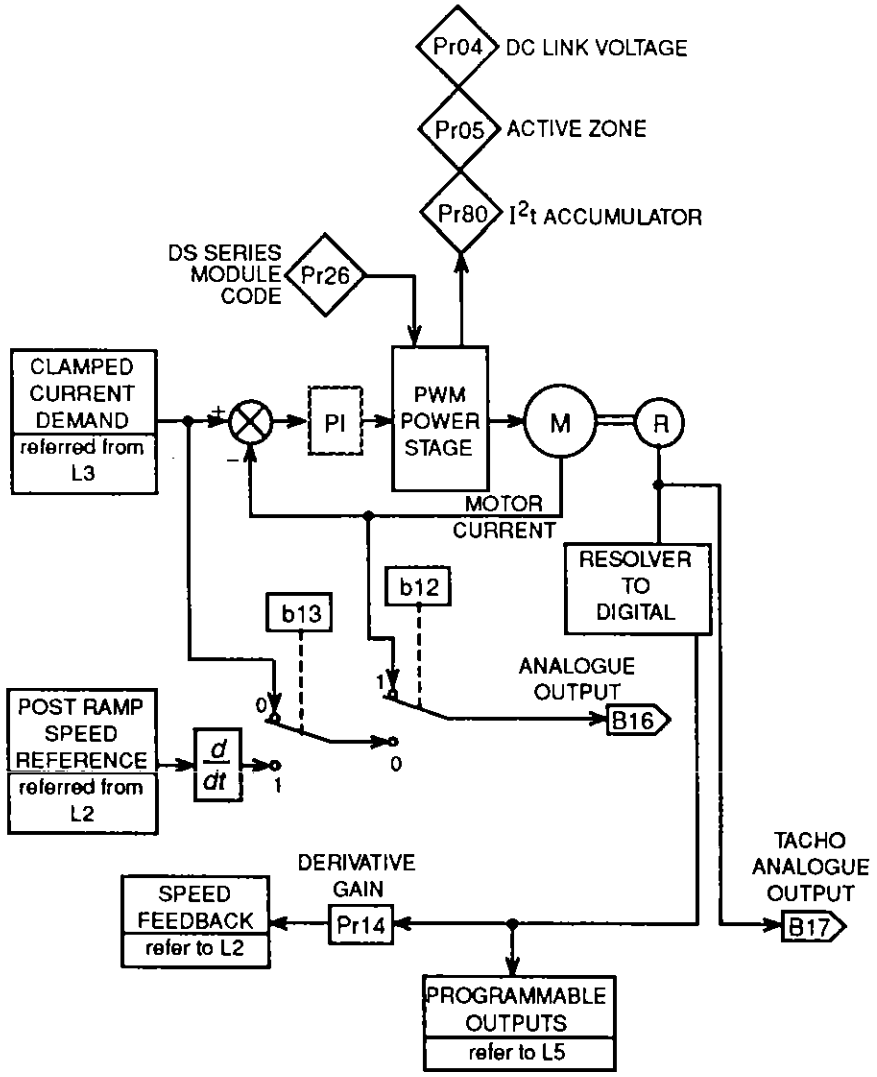
L1 Speed loop. Speed input references.



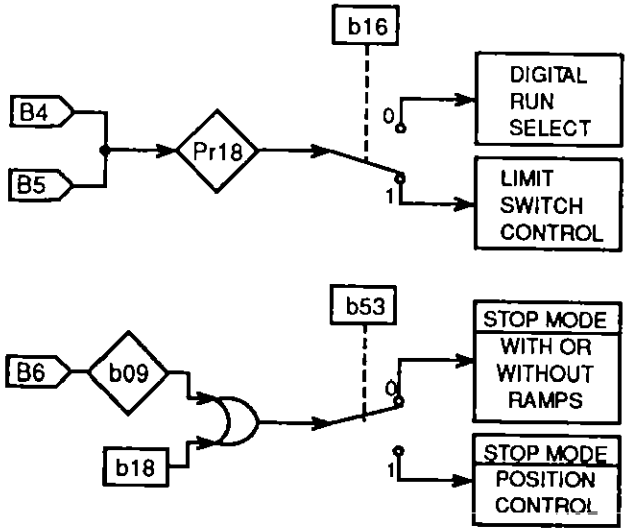
L2 Speed loop. Final speed reference.



L3 Current loop. Clamped current demand.



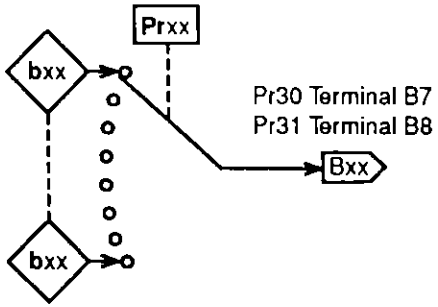
L4 Final current demand. Current and speed feedback loops.



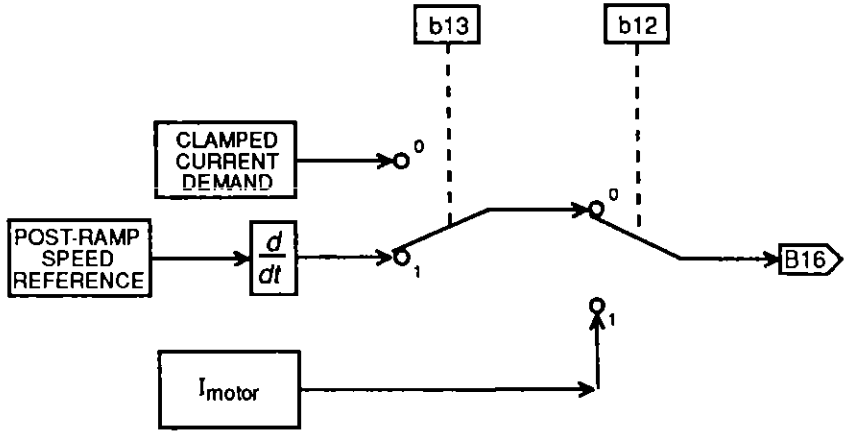
PROGRAMMABLE DIGITAL INPUTS

L5 Programmable inputs.

Prxx = 0	I^2t Alarm	**b89**
Prxx = 1	Overtemp. pre-alarm	**b91**
Prxx = 2	Overcurrent	**b84**
Prxx = 3	FWD/REV	**b38**
Prxx = 4	Zero Speed	**b41**
Prxx = 5	At Speed	**b42**
Prxx = 6	Saturation	**b48**

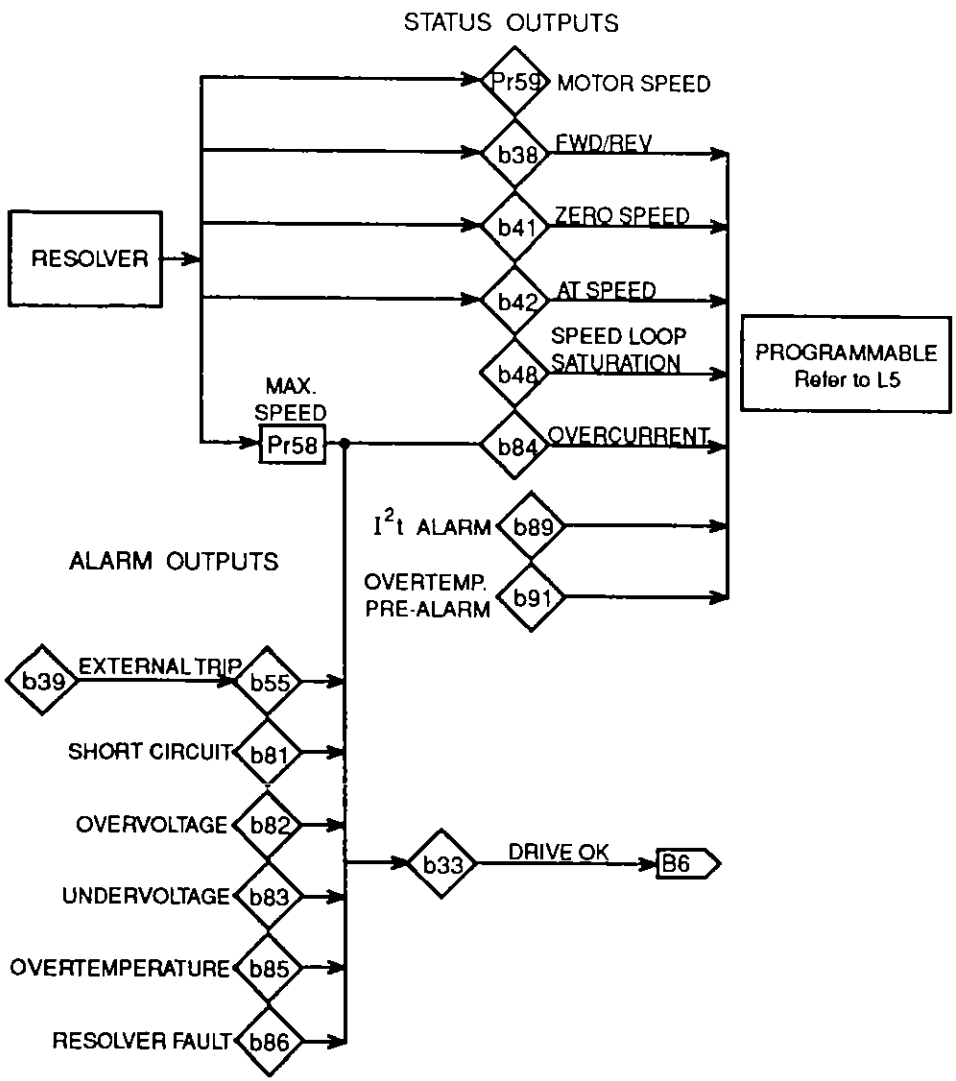


PROGRAMMABLE OUTPUTS

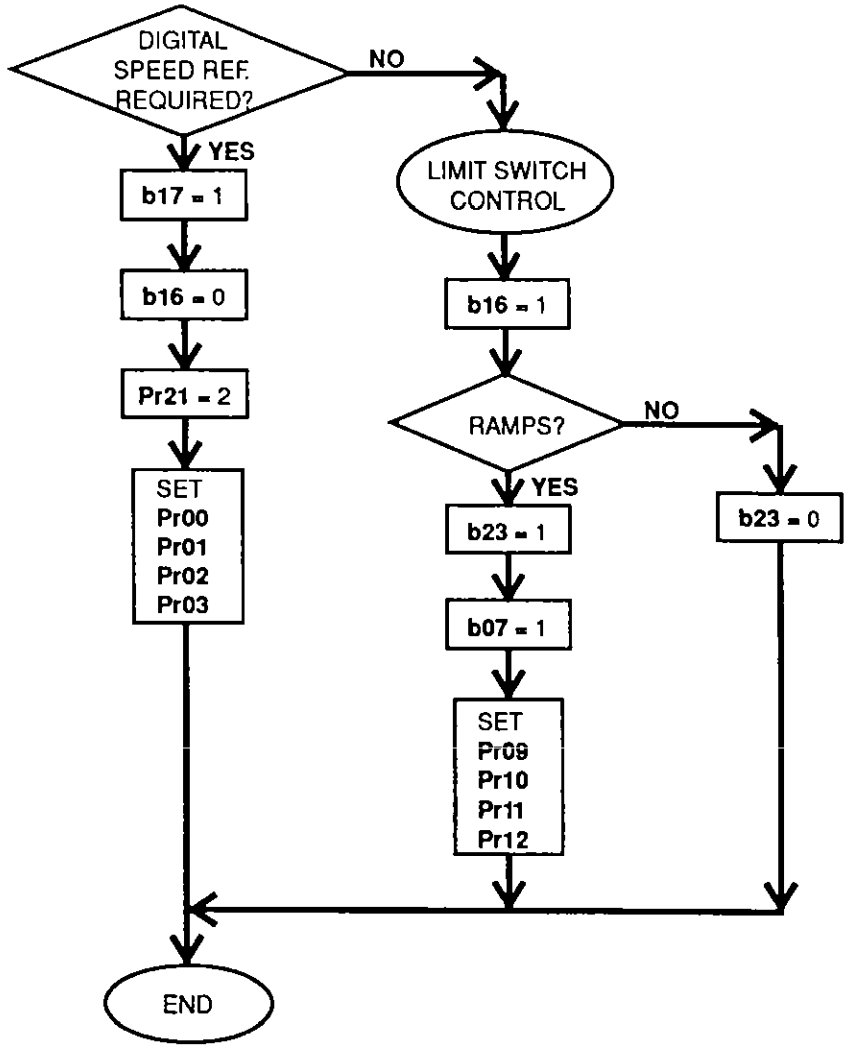


PROGRAMMABLE ANALOGUE OUTPUTS.

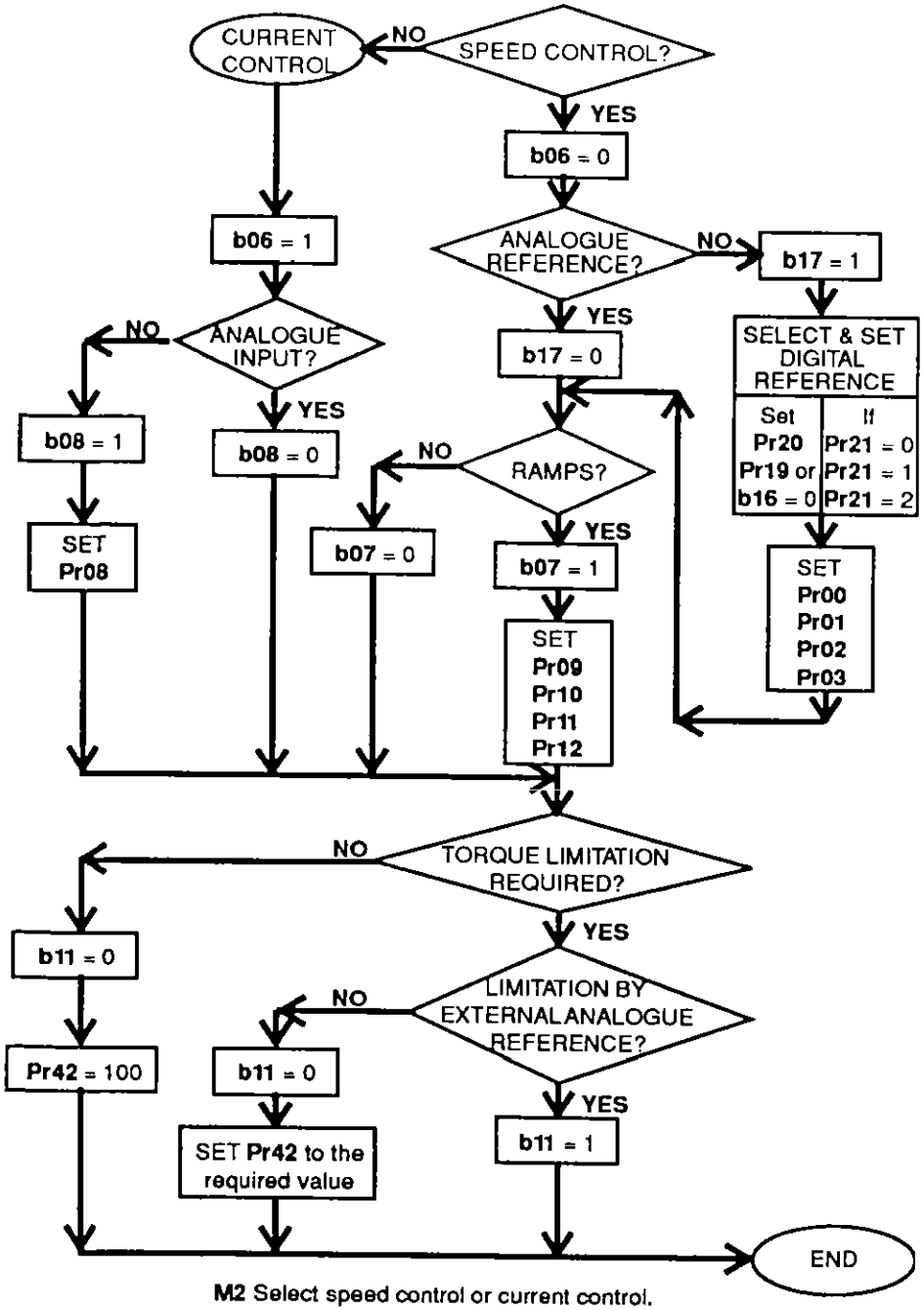
L6 Programmable outputs.



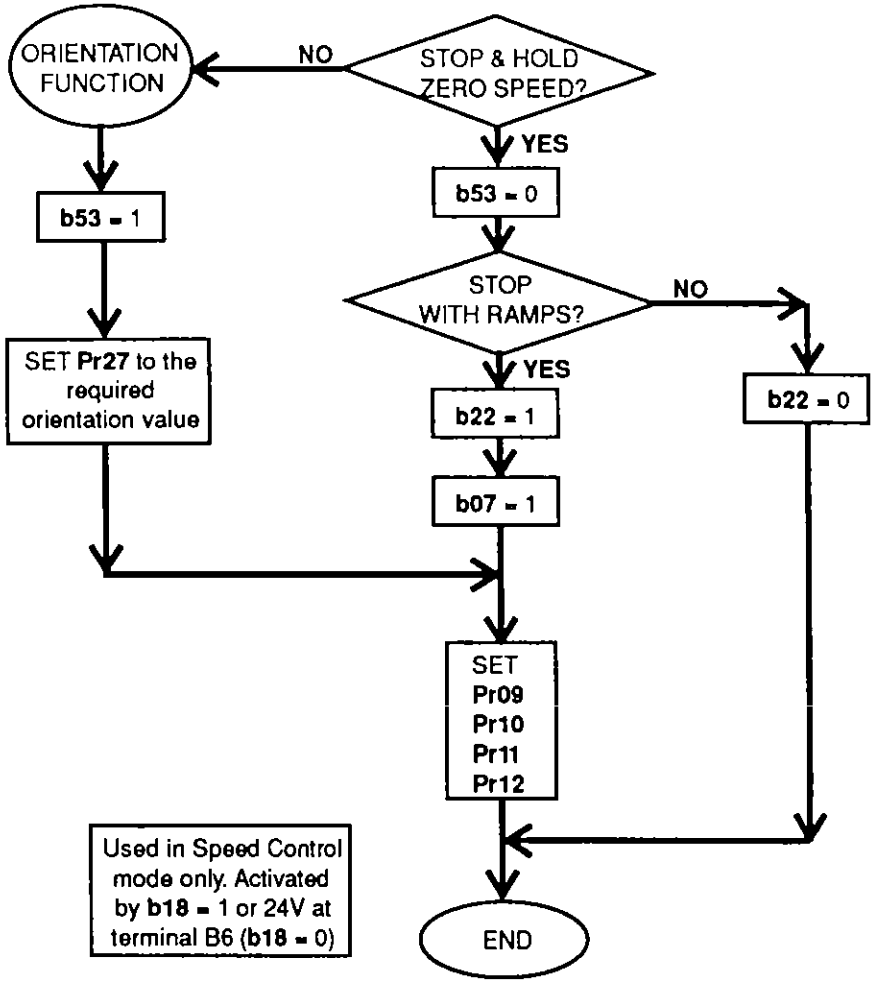
L7 Status and alarm outputs.



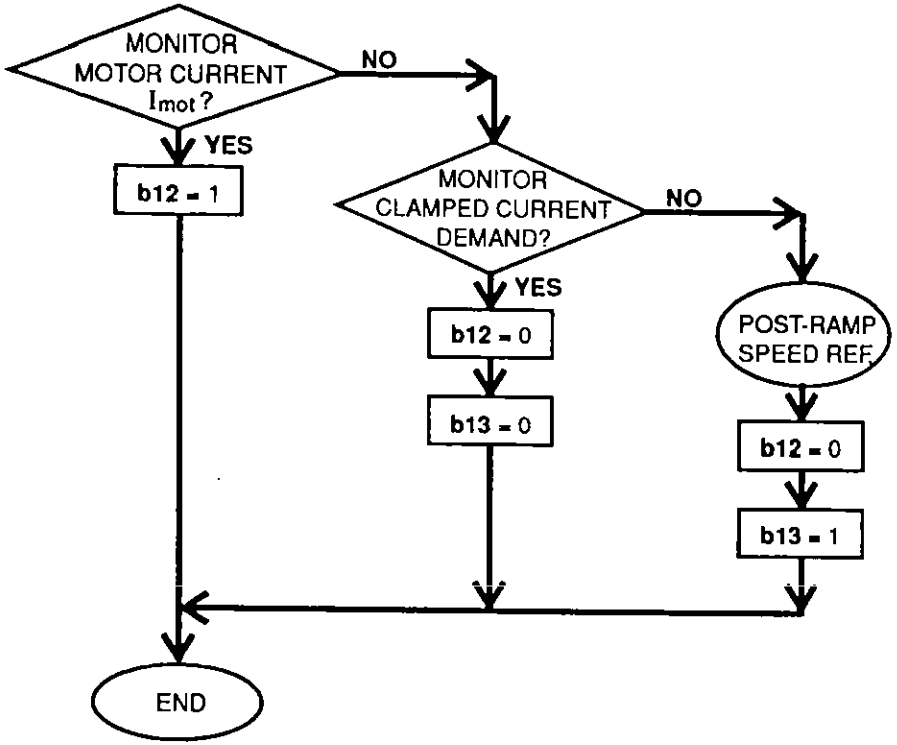
M1 Digital speed reference or limit switch function.



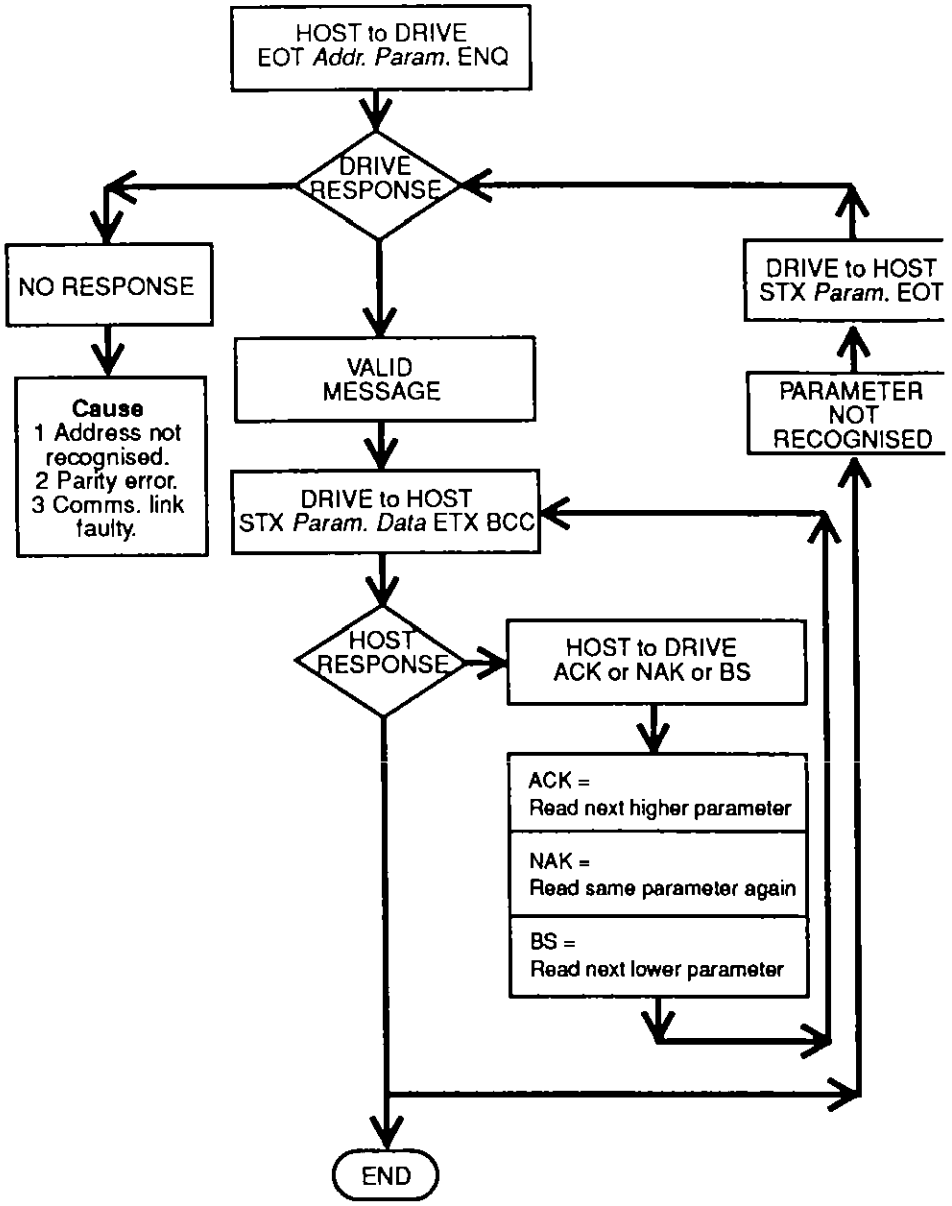
M2 Select speed control or current control.



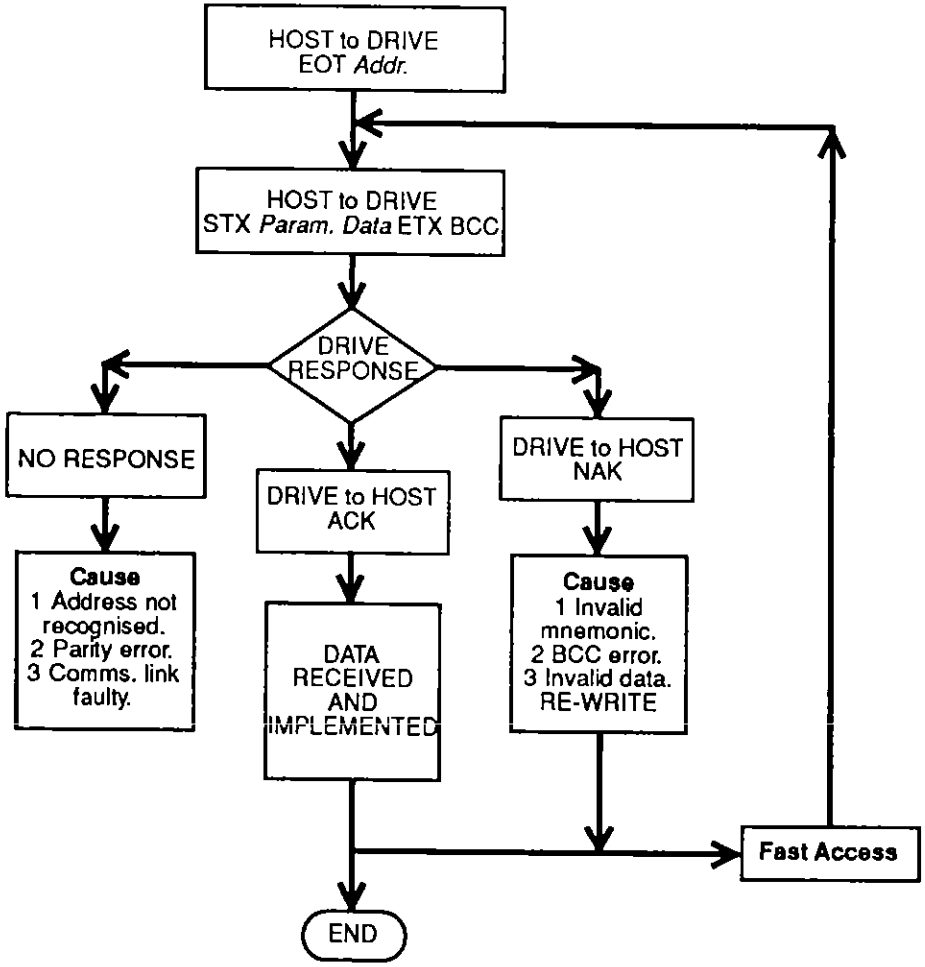
M3 Stop mode selection. Stop-and-hold, or stop-and-orientate to position.



M4 Output signal source selection, terminal B16.



S1 To read a parameter value.



S2 To write a command — change a parameter value.

VELOCITY MODE W/ ANALOG INPUT & HARDWARE

b2 = Ø
b7 = Ø
b14 = 1
b16 = Ø
b17 = Ø
b18 = Ø
b99 = Ø "SAVE"
b2 = 1 ENABLE DRIVE

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