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CE

BLH Brushless
Servo Drives
User Guide

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Part No: 1600.223.01 November, 1996

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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. Note that it may be necessary for the completed installation to comply with the Low Voltage Directive or the Machinery Directive. It is your responsibility as an installer 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.

The installation, set-up, test and maintenance procedures given in this User Guide should only be carried out by competent personnel trained in the installation of electronic equipment. Such personnel should be aware of the potential electrical and mechanical hazards associated with mains-powered motion control equipment - please see the safety warning below. The individual or group having overall responsibility for this equipment must ensure that operators are adequately trained.

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 any part of the equipment while it is in operation.

This product is sold as a motion control component to be installed in a complete system using good engineering practice. Care must be taken to ensure that the product is installed and used in a safe manner according to local safety laws and regulations. In particular, the product must be enclosed such that no part is accessible while power may be applied. If the equipment is used in any manner that does not conform to the instructions given in this User Guide, then the protection provided by the equipment may be impaired.

EMC INFORMATION

EMC Information is presented in boxed paragraphs (such as this one). Information in this User Guide consists of recommendations only; compliance is not guaranteed. BLH drives are sold as complex components for use by professional system builders. They are not intended for sale to end users.

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User Guide Change Summary

This user guide, version 1600.223.01, is the first version of the BLH Brushless Servo Drives User Guide. Previously, both the BLH and the BLHX drives were described in one user guide called: BLH/BLHX Brushless Servo Drives User Guide (part number 1600.188.03).

When a user guide is updated, the new or changed text is differentiated with a change bar in the outside margin (this paragraph is an example). If an entire section is changed, the change bar is located on the outside margin of the section title.

Warning symbols used on the BLH series of drives have the following meanings:



Refer to the accompanying documentation



Protective conductor terminal



Risk of electric shock



Alternating current



Hot surface



Frame or chassis terminal

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Product Type: **BLH30, BLH75, BLH150**

The above products are in compliance with the requirements of the following Directives, when installed in accordance with the instructions contained in this User Guide.

- **73/23/EEC** **Low Voltage Directive**
- **93/68/EEC** **CE Marking Directive**

The BLH Series of drives are sold as complex components to professional assemblers, as components they are not compliant with Electromagnetic Compatibility Directive 89/336/EEC. However, information is offered in this User Guide on how to install these drives in a manner most likely to minimise the effects of drive emissions and to maximise the immunity of drives from externally generated interference.

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Section 1. INTRODUCTION

Product Description

The BLH Series of drives are high performance, low-loss pulse width modulated DC servo drives suitable for use with Digiplan brushless (ML range) servo motors. They are supplied as boxed units and power-plate technology makes them capable of delivering a continuous output power of 100W to 1.2kW. Adjustable current limiting allows them to be matched to a wide range of motors.

The drives are fully protected against damage caused by overheating and by short-circuits across motor connections or to earth. Additional protection circuitry monitors the voltage rails within the drives and disables the power switches if these fall outside the specification.

A choice of three current ratings are available:

BLH30	3.75A continuous (7.5A peak)
BLH75	7.5A continuous (15A peak)
BLH150	15A continuous (30A peak)

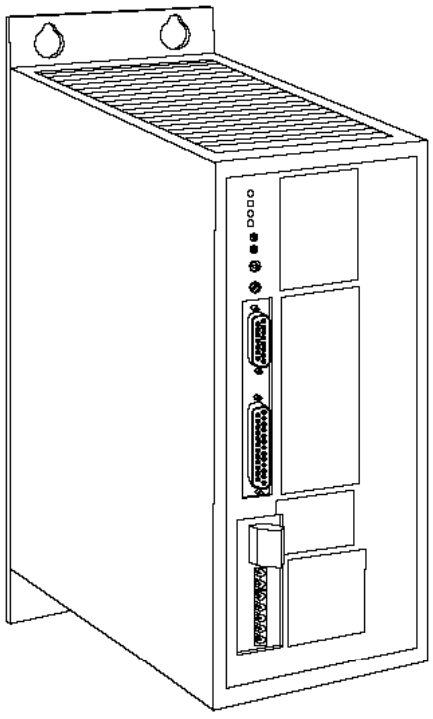


Figure 1-1. BLH Drive

The built-in power supply operates from a single AC input voltage and uses a switching regulator to generate low voltage supplies. The supply has a built-in power dump circuit which protects its circuits by absorbing the power generated by the motor during deceleration.

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Product Features

Protection Circuits

Adjustable Current Limit
Overcurrent
Overtemperature (Motor or drive)
Overvoltage
Output short circuit

Function Indicators

Current Limit
Drive Fault
Overtemperature
Logic Supply On

Adjustments

Tachometer gain
Balance
Time constant
Damping

Outputs and Inputs

Reset/Disable
Differential velocity/torque demand input
Fault output
Incremental encoder outputs
Digital tachometer output

Other Features

Power dump

Theory of Operation

The drive contains all the necessary circuitry to control a brushless DC servo motor. It must be used in conjunction with a mains isolating transformer as this produces a suitable AC supply voltage from the AC mains supply. It must not be run direct on-line as this would damage the drive and is unsafe.

The input to the drive is an analogue signal source, for example an analogue servo controller or simply a potentiometer. The drive generates motor currents required to achieve the motion from the servo motor and an encoder provides feedback to complete the basic system shown in Figure 1-2.

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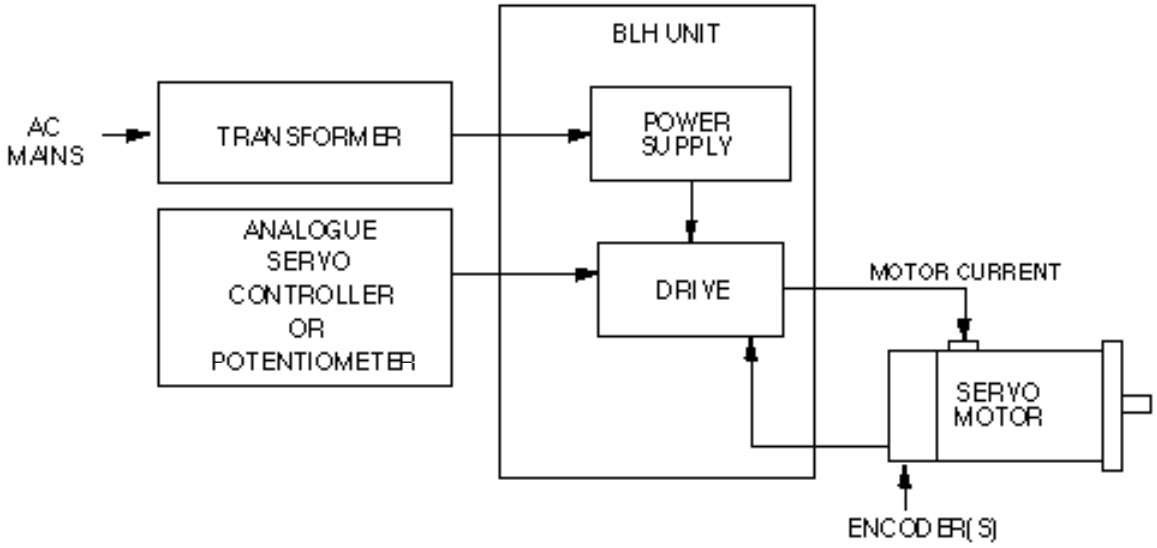


Figure 1-2. BLH Drive System Schematic

Controls and Indicators

LEDs

Current Limit LED (Yellow)

Illumination of this LED indicates that the axis is in current limit (does not disable the axis). This occurs if the rate of change of velocity demanded cannot be met by the drive or the torque request is greater than the set peak current.

Overtemperature LED (Red)

Illumination of this LED indicates overtemperature in the drive or the motor connected to it.

Drive Fault LED (Red)

This LED, when illuminated, indicates that there has been an incremental encoder signal loss, overcurrent or overvoltage. It will also illuminate if the 24V DC is present but the AC input is absent.

Logic Supply On (Green)

This LED indicates that the power to the logic circuits of the drive is present and correct.

Potentiometers

Balance

This 20 turn potentiometer is used to adjust the balance of the amplifier to give zero motor current when there is no velocity input demand.

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Tach Gain

The level of the velocity feedback is adjusted by this 20 turn potentiometer.

Time Constant

The Time Constant single turn potentiometer and associated components determine the bandwidth of the amplifier.

Damping

This single turn potentiometer adjusts the response characteristic of the amplifier so that the axis achieves the demanded velocity without overshoot.

Jumper Links

BLH drive options are selected by means of nine jumper links as shown in Figure 1-3. A full description of the jumper link functions will be found under "Setting Up the Drive". See Table 3-8 for Current Limit link settings and Figure 3-7 for Pull Up/Pull Down on disable input.

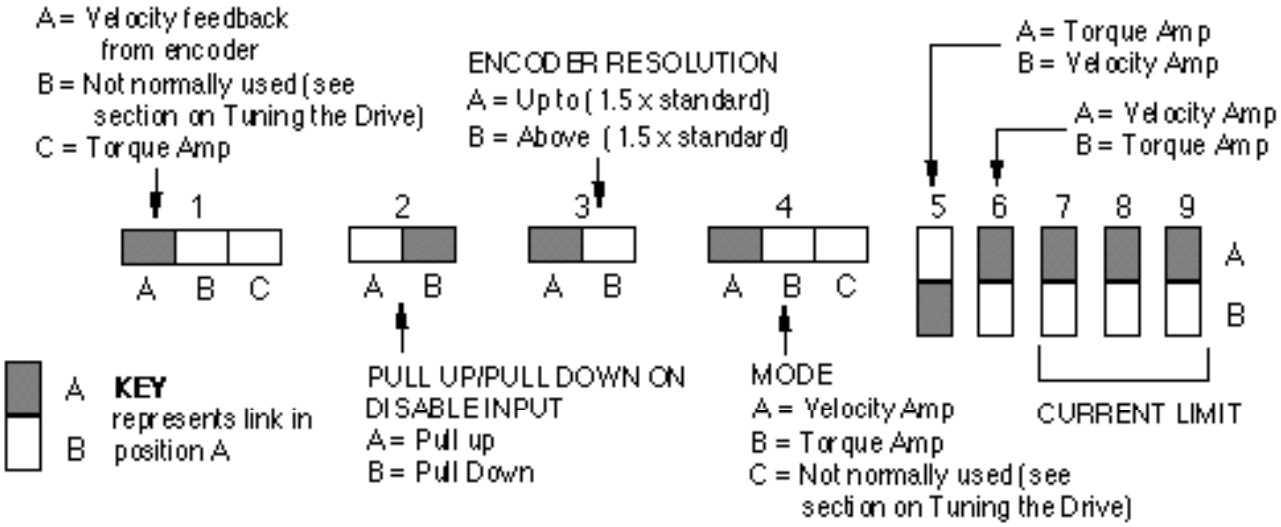


Figure 1-3. Jumper Link Setting Schematic

Factory Default Link Positions	1	2	3	4	5	6	7	8	9
BLH	A	B	A	A	B	A	A	A	A

Table 1-1. Factory Default Jumper Link Positions

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Section 2. GETTING STARTED

Objectives

The information in this section will help you to do the following:

- Verify that each component of your system has been delivered correctly.
- Become familiar with system components and their interrelationships.
- Establish the basic system configuration.
- Ensure that the drive functions correctly.

Take care, unexpected motion may occur at any time, especially during the commissioning of motion control equipment.

What You Should Have

Upon receipt, you should inspect your BLH Drive Drive system delivery for obvious damage to its container. Report any damage as soon as possible. The items listed in Table 2-1 should be present and in good condition. To verify that you have the proper drive model, check the model number listed on the drive serial plate.

Ship Kit Table

Part Description	Part Number
BLH Drive	BLH30, BLH75, BLH150
Optional Transformers: Model TO92 Model TO170 Model TO171	 2050.036.XX 2050.120.XX 2050.121.XX
BLH User Guide	1600.223.XX
Motor Cables: For ML2340 motor For ML3450/ML3475 motor For ML1620	 23M-CABLE-XX* 34M-CABLE-XX* Supplied with motor, fixed length of 10 feet (3.0m).
Encoder Cables For ML23 & ML34 motors For ML1620	 MLEN-CABLE-XX* Supplied with motor, fixed length of 10 feet (3.0m).

* Length of cable specified in feet. Standard sizes are 10 (3.0m), 25 (7.6m), 50 (15m), 75 (22.8m)

Table 2-1. BLH Drive Ship Kit

Systems may be shipped configured with drives and motors prewired or supplied as separate units.

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Pre-installation Test

This section provides procedures to help you to connect up your BLH drive system for a pre-installation test. *A temporary bench-top configuration is used for the pre-installation test.* Detailed permanent installation instructions are provided in Section 3, Installation.

Figure 2-1 illustrates the pre-installation test configuration for a system operating from a 240V mains supply. BLH Series drives must be installed by competent personnel familiar with the installation, commissioning and operation of motion control equipment.

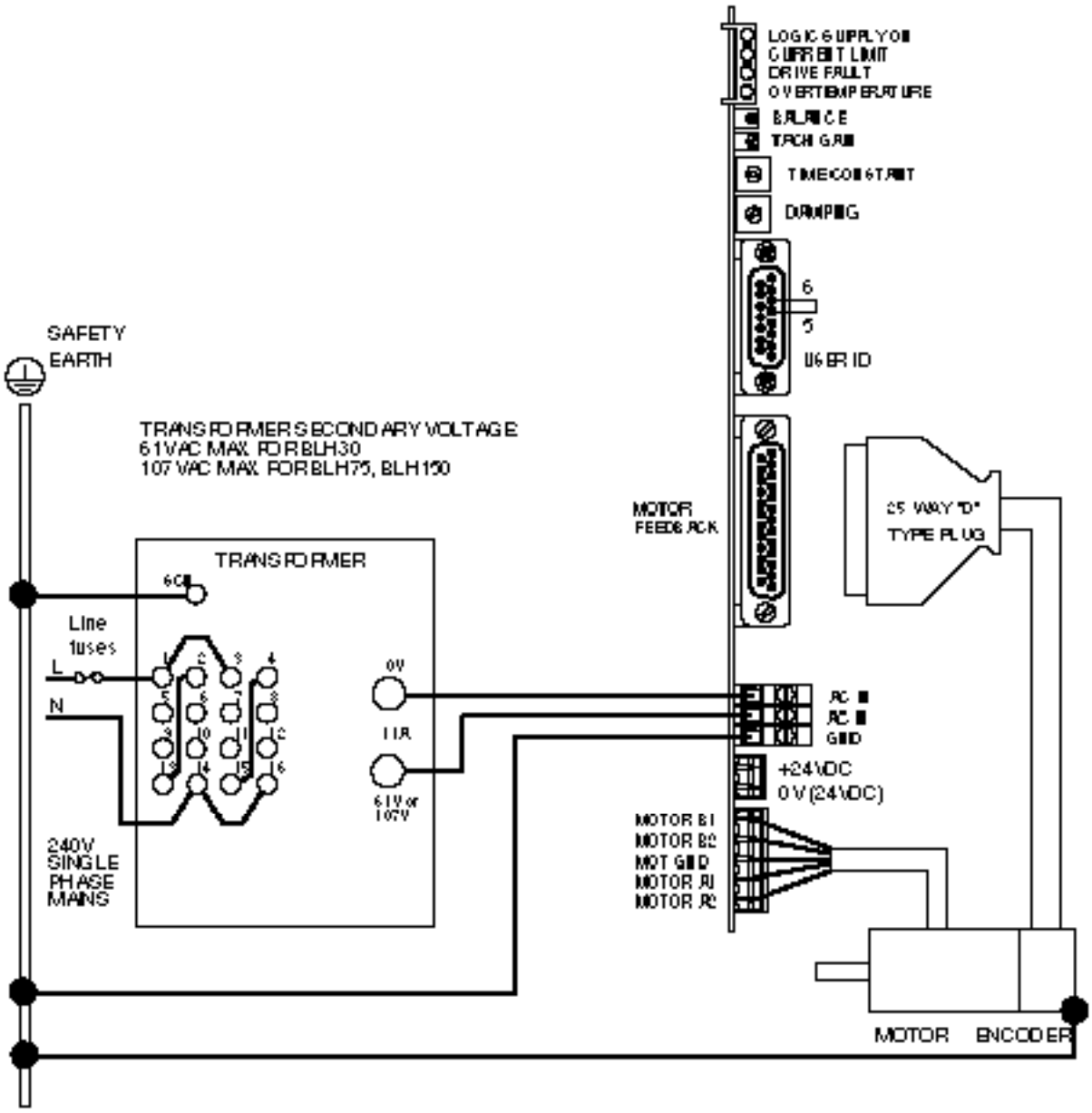


Figure 2-1. Pre-installation Test Configuration (240V AC Mains Supply)

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Figure 2-2 shows the pre-installation test configuration for a systems operating from a 120V AC mains supply.

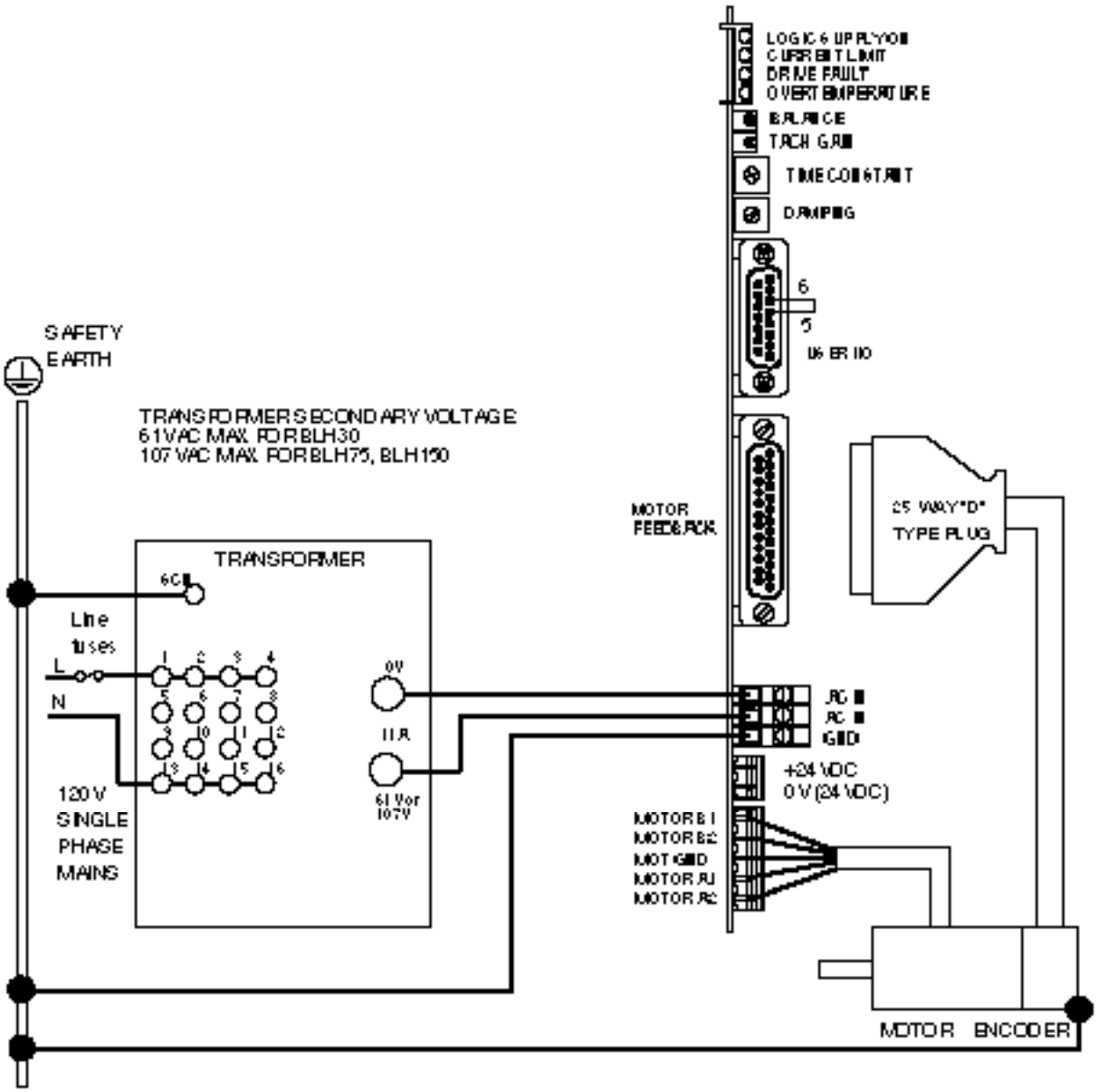


Figure 2-2. Pre-installation Test Configuration (120V AC Mains Supply)

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Connect the Motor

WARNING

Ensure that AC power is disconnected before attempting to connect or disconnect the motor. Hazardous voltages are present on the motor connectors.

Motor and feedback connectors are pre-wired. Plug the 5-way screw terminal connector into the Motor socket and the 25-way D connector into the Motor Feedback socket. During final installation it may be necessary to extend the leads or re-wire the connectors - information on lead colours etc. will be found in Section 3 "Installation".

Connect the Transformer

The motor and logic supplies are derived from a single-phase isolating transformer, which should be rated for the total loading. This clearly depends on the duty cycle, but would be typically 2.5A @ 61V for the BLH30, 6A @ 107V for the BLH75 and 11A @ 107V for the BLH150. You should install an in-line fuse suitably rated for the AC supply and the transformer loading in the live lead to the transformer primary (see Figure 2-1 & 2-2). Normally, the BLH system is shipped with one of the Digiplan transformers: TO170, TO171 or TO92.

Before connecting the AC supply leads, measure the secondary voltage(s) from the isolating transformer. These should not exceed 61V AC for the BLH30 or 107V AC for the BLH75 or BLH150 at the nominal AC input voltage.

WARNING - danger of electric shock

Mains voltages are dangerous. Ensure that all terminals are adequately insulated to prevent accidental contact.

Connection Examples

Figures 2-1 and 2-2 illustrate connections for standard Digiplan transformers.

Testing the BLH System

1. Set the drive potentiometers as follows:

TIME CONSTANT	Fully CCW
DAMPING	Fully CCW
TACH GAIN	Fully CW

2. If the drive has been supplied configured for a particular motor type, the drive jumper link settings need not be changed. Factory default settings can be used for performing the pre-installation test.

   Note: The BLH is always supplied configured as a velocity amplifier.

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3. **Make sure that the motor is held securely** and that the shaft is free to rotate.

4. Turn the Time Constant and Damping controls fully CCW and the Tach Gain control fully CW.

5. Turn on the 24V supply (if used) and the main AC supply.

6. Rotate the Balance control until the motor shaft remains stationary. Rotating the Balance control CW should cause the motor to rotate CW and therefore, rotating CCW should cause the motor to rotate CCW. This confirms that the drive is working.

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Section 3. INSTALLATION

Section Objectives

The information in this section will enable you to do the following:

- Mount all system components
- Connect all system inputs and outputs
- Ensure that the system is installed properly
- Perform basic system tests

The BLH drive can be installed in two ways:

- Normal installation
- EMC installation

The BLH Series of drives are not EMC compliant, they are sold as a complex component for use by professional assemblers of motion control systems. Where a system is not required to conform with the European EMC directive the installation procedure described in this Section may be followed. Systems which are are to conform to the European EMC directive should be assembled using these procedures and additionally the EMC specific installation recommendations, described at the end of this Section. Digiplan cannot guarantee compliance.

BLH Series drives must be installed by competent personnel familiar with the installation, commissioning and operation of motion control equipment.

This section also covers mains transformer information.

Environment

The operational temperature range for the drive system is 0°C to 50°C (32°F to 122°F) and at a relative humidity between 0 and 95% (non-condensing). Make sure the system is stored in temperatures within the range from -40°C to 85°C (-40°F to 185°F).

The mains input to the isolating transformer is Installation Category III maximum.

The BLH Series of drives can be used in a Pollution Degree 2 environment i.e., one in which only non-conductive pollution occurs.

The drive system should be installed in an area where there is adequate ventilation above and below the packages. In some applications involving high duty cycles, ventilation fans may be required. In the final application the equipment must be enclosed to prevent the operator coming into contact with any high voltages. This includes the transformer, drive and motor terminations.

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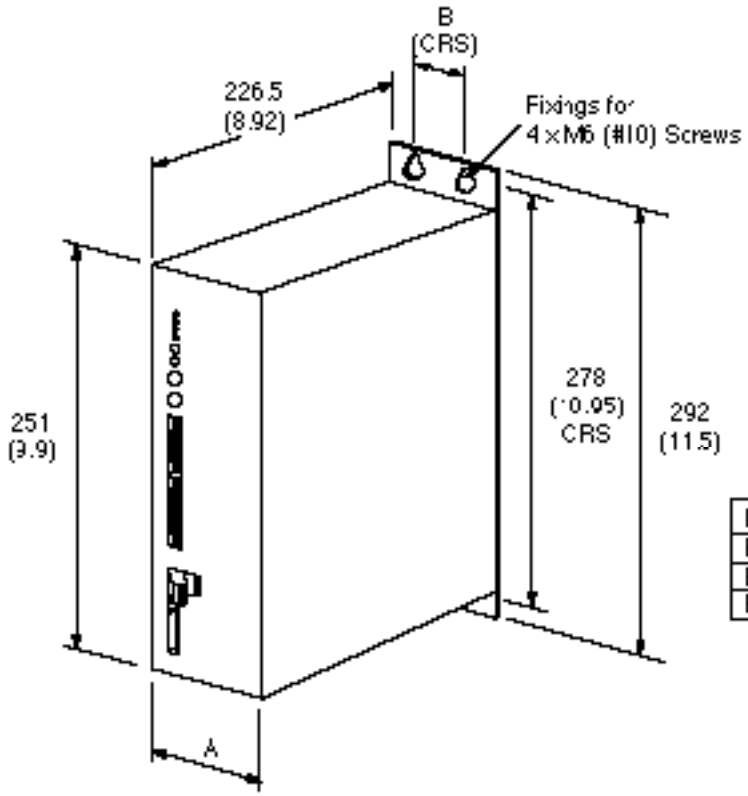
Metal equipment cabinets offer the most advantages for siting the equipment since they can provide operator protection, EMC screening and can be readily fitted with interlocks arranged to remove all AC power when the cabinet door is opened. This form of installation also allows the fitting of metal trays beneath the equipment to act as a flame barrier, which should be provided in the final installation, in accordance with LVD requirements.

Mounting the Drive

All BLH drives are supplied as packaged units. Figure 3-1 shows the mounting methods and overall dimensions.

Enclosure Considerations

You should install the drive system in an enclosure to protect it against atmospheric contaminants such as oil, moisture, dirt etc. and also to prevent operator access. Ideally, you should install the system in a rack cabinet. In the USA, the National Electrical Manufacturers Association (NEMA) has established standards that define the degree of protection that electrical enclosures provide. The enclosure should conform to NEMA Type 12 standards if the intended environment is industrial and contains airborne contaminants. Proper layout of components is required to ensure sufficient cooling of equipment within the enclosure.



UNITS: mm(inches)

Drive Type	A	B
BLH30	50.5 (2.0)	30.5 (1.2)
BLH75	70.8 (2.79)	40.8 (1.61)
BLH150		

Figure 3-1. Mounting the Drive

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Package Assembly

You can gain access to a drive or positioner card by removing the screws shown in Figure 3-2.

WARNING

Ensure AC power is removed before removing any drive covers.

Note: the position of screws will vary depending on the drive type.

To avoid frequent removal and replacement of panels, you should determine the necessary link connections by reference to ***Setting the Drive Jumper Links*** later in this section.

Link changes will not be necessary if a drive is used which has been pre-configured for a particular motor type.

REMEMBER - SET LINKS BEFORE INSTALLATION.

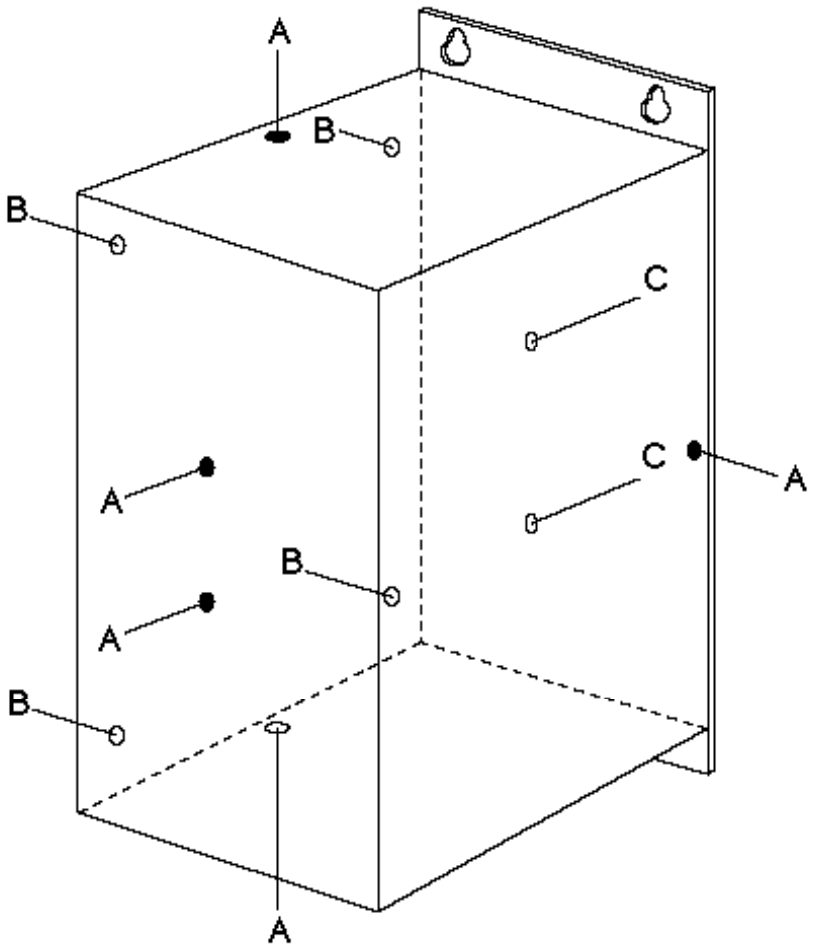


Figure 3-2. Assembly Screw Locations

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Screw Types

Screw types A and B, shown in Figure 3-2, are all M3 round head, screw type C is M3 countersunk.

Mains Transformer

This section describes the range of mains transformers suitable for use with BLH drives available from Digiplan. It is advisable to test that either 61VAC (for an 85V DC motor supply) or 107VAC (for a 150V DC motor supply) is obtained on the secondary of the transformer used before connecting it to the equipment. The equipment will be damaged if the voltage is too high. A qualified electrician should carry out this work.

NOTE: It is our convention to quote transformer secondary voltages in the open circuit condition.

To use the system on a different mains supply, you will need to change the transformer connections. The information given in this section will show you how to do this.

For mains wiring, use approved mains cable of at least 0.75mm^2 CSA, taking care to keep all mains wiring away from all secondary and signal wiring. Ensure that the transformer terminations are suitably enclosed to prevent operator contact, either by fitting a suitable cover or enclosing the transformer within a housing. Note: If a low power secondary winding is used, e.g., 20V AC, it must be separately fused with an in-line fuse in the wire close to the transformer. The fuse value should be approximately twice the current rating of the secondary winding being used (with a time delay characteristic).

Table 3-1 shows details of the transformers available. These are all for single phase operation.
If an alternative transformer is used it must have an earthed screen between the primary and secondary windings. For safety reasons the insulation between the primary and secondary must be adequate. A minimum of 2300V AC withstand voltage between the primary and secondary is recommended.

Type	DC Supply	VA Rating	Suitable Drive
Model TO92	85v	700	BLH30
Model TO170	150v	1300	BLH75, BLH150
Model TO171	150v	2500	BLH75, BLH150

Table 3-1. Optional Mains Transformers

Figures 3-3 and 3-4 show the transformer connections when used with 240VAC mains supplies and 120VAC mains supplies respectively.

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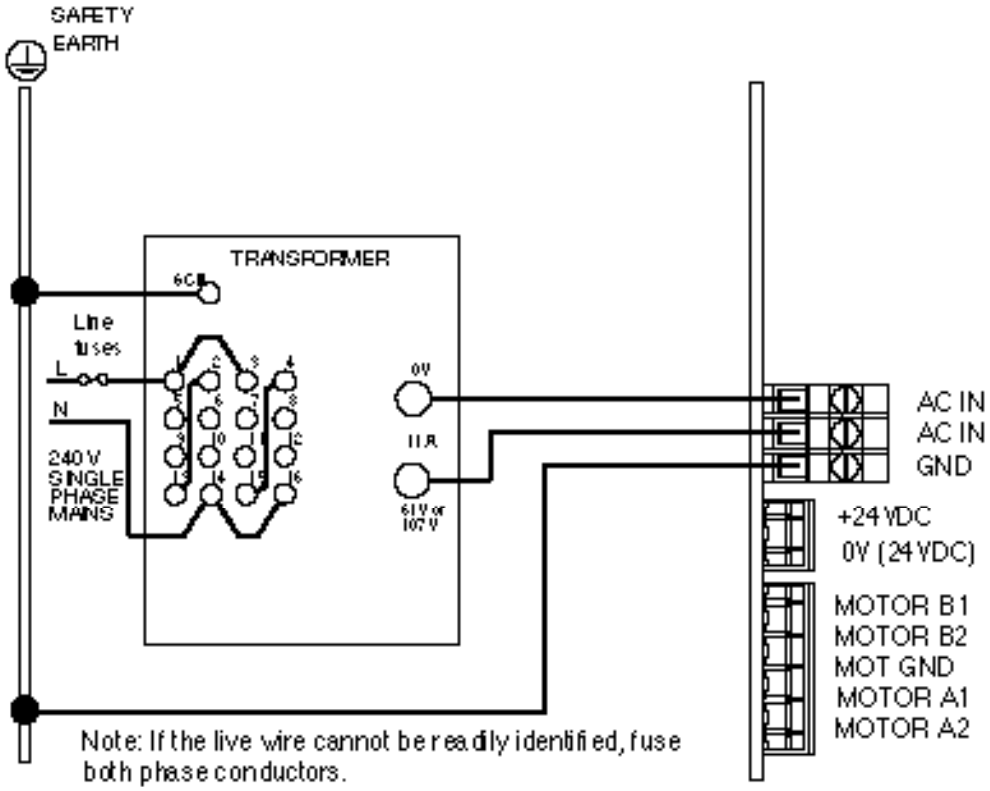


Figure 3-3. 240VAC Connections

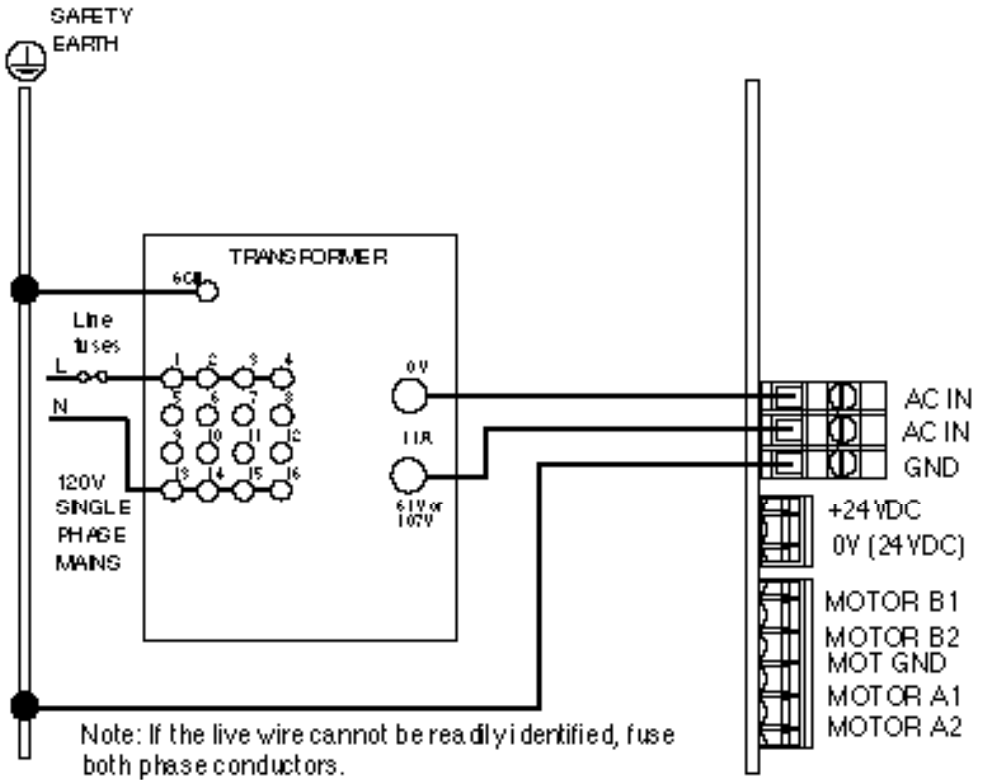


Figure 3-4. 120VAC Connections

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Primary Fuse Ratings

Primary fuses need to be rated to protect the transformer and secondary wiring from short circuit faults whilst withstanding the primary in-rush current at power up. The fuse rating can be calculated as follows:

$$\text{Fuse rating (A)} = \frac{\text{Transformer VA} \times 1.5}{\text{Supply volts}}$$

Fuses need to be of the anti-surge high breaking capacity type, which have a limited range of values, consequently you may need to select the next highest standard value rather than the calculated value. For example, a 700VA transformer used with a supply of 240V will require a 4.4A fuse, consequently the next highest standard value of 5A will need to be selected.

Disconnect Device

A disconnect device must be provided which isolates all mains supply current-carrying conductors. If the mains supply is permanently connected, a switch or circuit breaker must be included in the wiring. It must be placed close to the equipment (less than 1 metre) and marked as the disconnecting device for the equipment.

Voltage Adjustment

Table 3-2 gives details of the terminal connections for the range of mains input voltages. Input voltages in the range 360 to 480V are for connection across two phases of a three phase supply.

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Input voltage	Primary connections		Jumper Links
	Line 1	Line 2	
100	1	9	1-2-3-4, 9-10-11-12
110	5	13	5-6-7-8, 13-14-15-16
120	1	13	1-2-3-4, 13-14-15-16
200	1	10	9-2, 11-4, 1-3, 10-12
220	5	14	13-6, 15-8, 5-7, 14-16
230	1	14	1-3, 13-6, 15-8, 14-16
240	1	14	1-3, 13-2, 15-4, 14-16
360	5	12	9-6, 10-7, 11-8
380	5	16	9-6, 10-7, 11-8
400	1	12	9-2, 10-3, 11-4
420	1	16	9-2, 10-3, 11-4
440	5	16	13-6, 14-7, 15-8
460	5	16	13-6, 14-3, 15-4
480	1	16	13-2, 14-3, 15-4

Table 3-2. Transformer Connections

The mains earth must be connected to the transformer screen on terminal SCN.

Transformer Connections

Where several drives are to be operated from the same isolating transformer, it is desirable that a separate secondary winding is provided for each drive. If this is not possible, ensure that the wiring impedance of each drive is closely matched by connecting each unit individually back to the transformer using equal lengths of wire. Do not 'daisy chain' drives by looping the AC input from one to the next.

Insulation rating of the secondary power connections should be at least 600V, where this is between power and signal circuits. Insulation requirements to mains wiring are higher.

Motor

The motor body must be reliably earthed. The impedance to the earth star point should be less than 0.1Ω.

WARNING - Hot surface

The case of a motor can become hot. Precautions may need to be taken to prevent operator contact.

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Drive Signal Connections

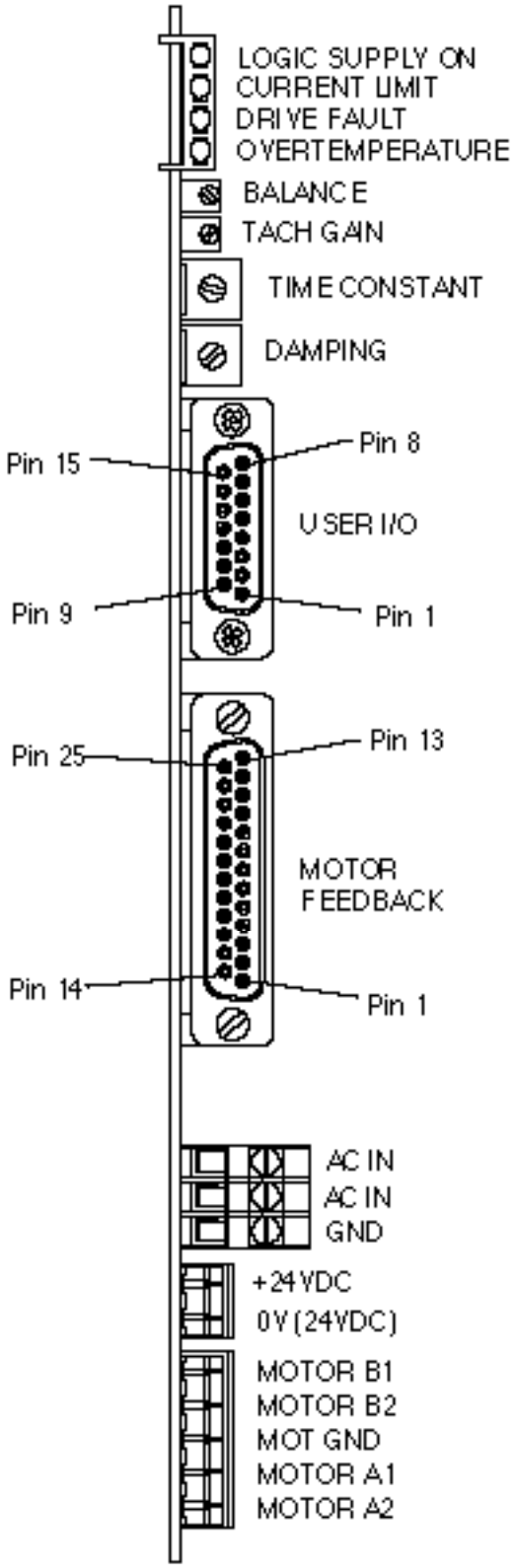


Figure 3-5. Connectors and Indicators

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User I/O Connector Pin Functions

Pin	Signal Name	Function	Signal Type
1	V2	Analogue velocity input	L
2	V1	Analogue velocity input	L
3	-15v	Reference voltage	O
4	GND	Ground	Q
5	$\overline{\text{RST}}$	Reset/Disable	P
6	+15V	Reference voltage	O
7	Tach out	Analogue tachometer output (digitally derived)	R
8	Not used		
9	$\overline{\text{FT}}$	$\overline{\text{Fault}}$	N
10	AOP *	A output from incremental encoder	M
11	$\overline{\text{AOP}}$	$\overline{\text{A output}}$	M
12	BOP *	B output from incremental encoder	M
13	$\overline{\text{BOP}}$	$\overline{\text{B output}}$	M
14	ZOP **	Z output from incremental encoder	M
15	$\overline{\text{ZOP}}$	$\overline{\text{Z output}}$	M

* AOP leads BOP for CW motor rotation

** ZOP is a once-per-rev high-going pulse, covering $\frac{1}{4}$ of a channel AOP cycle and occurring when AOP and BOP are both high - see below;

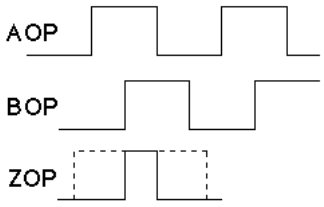


Table 3-3. User I/O Connector Pin Functions

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ML23/34 Motor Connector Pin Functions

Signal Name	Function	Signal Type	Lead Colour
Motor A1	Motor phase A1	I	White
Motor A2	Motor phase A2	I	Yellow
MOT GND	Motor ground	J	Green
Motor B1	Motor phase B1	I	Brown
Motor B2	Motor phase B2	I	Grey

Table 3-4. ML23/34 Motor Connector Pin Functions at the Drive End

ML1620 Motor Connector Pin Functions

Signal Name	Function	Signal Type	Lead Colour
Motor A1	Motor phase A1	I	Red
Motor A2	Motor phase A2	I	Yellow
Motor B1	Motor phase B1	I	Brown
Motor B2	Motor phase B2	I	Orange

Table 3-5. ML1620 Motor Connector Pin Functions at the Drive End

Note: The ML1620 motor should only be used with the BLH30 drive.

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Motor Feedback Connector Pin Functions (25-way D-type)

Pin Number	Function	Signal Type	Original Colours for Motor Connections	Latest Colours for Motor Connections
1	not used			
2	0V	E twisted	black	black
3	+5V	D pair	red	red
4	NC			
5	NC			
6	*MOT	F twisted	red	grey
7	MOT	F pair	green	pink
8	Z-	C twisted	red	yellow/brown
9	Z+	C pair	white	white/yellow
10	B-	C twisted	black	yellow
11	B+	C pair	orange	green
12	A-	C twisted	black	white
13	A+	C pair	brown	brown
14	NC			
15	0V	E twisted	blue	black
16	+5V	D pair	red	violet
17	NC			
18	*A3	C twisted	black	red/blue
19	A3	C pair	white	grey/pink
20	*A2	C twisted	black	white/grey
21	A2	C pair	green	grey/brown
22	*A1	C twisted	black	white/pink
23	A1	C pair	blue	pink/brown
24	*A0	C twisted	black	white/green
25	A0	C pair	yellow	brown/green

*indicates the inverse of a signal

Table 3-6. Motor Feedback Connector Pin Functions

Note: Encoder cable wire colours have been changed. Each wire now (far right column) has an individual colour, avoiding the potential problem of incorrect wiring caused by multiple black wires. The wiring at the motor end depends upon the type of motor being used (ML2340 or ML3450/ML3475). For more details of motor wiring see the Hardware Reference Section.

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AC In Connector

Signal Name	Function	Signal Type
AC IN	AC supply voltage from mains transformer	G
AC IN	AC supply voltage from mains transformer	G
GND	Mains earth safety connection	H

Table 3-7. AC Input Connector Pin Functions

24V DC Connector

Signal Name	Function	Signal Type
+24V DC	+24V DC supply to drive	A
0V (24V DC)	0V of 24V DC supply to drive	B

Table 3-8. 24V Supply Connector Pin Functions

Key to Signal Types

A +24v supply to drive
B 0V of 24V supply to drive
C Differential encoder input
D Encoder supply voltage
E Encoder supply 0V
F Motor overtemperature input
G AC input from mains transformer
H Ground for mains transformer screen
I Motor supply
J Motor Ground
L Analogue velocity demand signal
M Differential output from incremental encoder
N Open collector output
O Reference voltage out (10mA max.)
P Active low control input
Q Logic supply ground
R Analogue tachometer output

Using an External +24V Supply

The BLH drive has an on-board switch-mode power supply. This supply normally runs from the AC input. If it is required that the logic supply of the drive be maintained even when the AC input is removed (to keep the encoder count valid if this is fed to an external positioner)

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a 24V DC supply can be connected to this 2 pin socket. This will maintain all the logic supplies when the AC input is removed. When the AC input is restored, the current from the 24V DC supply, normally about 750mA, falls to zero.

Using an External Positioner

The incremental encoder incorporated in the motor may be used to provide position information to an external positioner. Terminals 10-15 on the User I/O connector provide the true and complementary signals from all three encoder channels (see Table 3-3). These outputs are generated by 26LS31 line drivers.

Rewiring the Motor Connections

If it is necessary to disconnect the feedback cable for any reason (to feed it through a conduit, for example) it is recommended that it is disconnected at the motor end. To do this, loosen both gland nuts, take off the terminal cover by removing the 4 retaining bolts, **make a careful note of where each pair of wires is connected** and then loosen all the screw terminals to remove the cable.
If you need to extend the feedback cable, use 20-way (10-pair) twisted-pair shielded cable such as Lapp 0035805, Cablemaster Type OS 10P 24 or Belden Type 9510. Where one lead of a twisted pair is black, take care to use the correct black lead at the other end. See Appendix A for more detailed information on extending the cable.

The main motor cable has 5 leads and is terminated in a 5-way screw terminal connector. This connector is easily removed and refitted where necessary. The lead colours are shown in Table 3-4; make a note of where each colour wire is connected before proceeding and take particular care that the leads are reconnected correctly. If a longer motor cable is required, remove the existing cable completely and replace it with 5-core shielded cable as follows:

1620 motor -	0.4mm^2 (20AWG)
2340 motor -	0.75mm^2 (18AWG)
3450 motor -	1.5mm^2 (14AWG)
3475 motor -	1.5mm^2 (14AWG)

Please consult Digiplan if you propose to extend the motor and feedback leads beyond 50 metres.

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Setting Up the Drive

Application Types

There are two basic types of applications (described below) for the BLH servo drive. Each type of application requires a different type of tuning.

Velocity Following

For this application, it is required that the axis follows programmed velocities as accurately as possible. A high amplifier gain is needed so that the small signals resulting from small velocity errors will produce a large correcting torque.

Torque Amplifier

In this type of application, the torque produced is required to be proportional to the input voltage. Low amplifier gain is needed in this case. The torque produced directly relates to the motor current. For example, a gain of 1A/Volt would produce 1A of motor current for each volt at the input (±10V at the input would produce ±10A of motor current).

Initial Precaution

Before starting to tune the drive ensure that the motor mechanism is clear of obstructions. Position the mechanical system at the mid-position of its total travel. Do not allow the motor to remain unstable for more than a second or two.

Setting the Drive Jumper Links

Depending on how you want to use the drive, you may need to change some of the factory-set link positions. Figure 3-6 shows the positions and functions of all the jumper links. See Table 3-8 for Current Limit link settings and Figure 3-7 for the Pull Up/Pull Down on Disable Input.

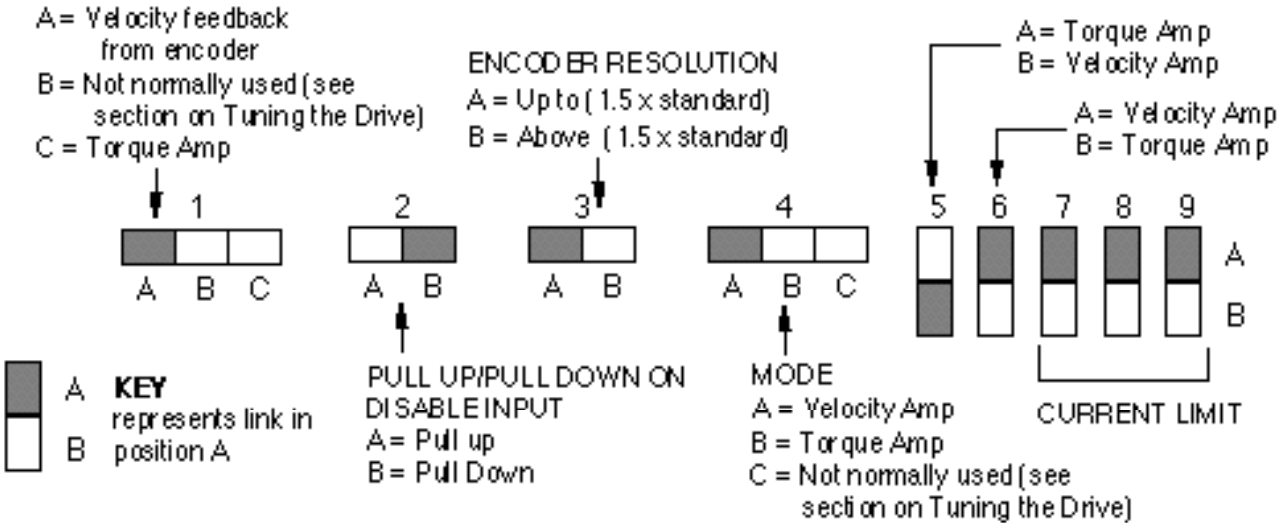


Figure 3-6. Jumper Link Setting Schematic

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Velocity or Torque Amplifier

The BLH drive would normally be used as a velocity amplifier, in which case the jumper links are set as follows:

Link 1 = A Link 5 = B
Link 4 = A Link 6 = A

To use the drive as a torque amplifier (so that input voltage now determines torque rather than velocity), set the jumper links as follows:

Link 1 = C Link 5 = A
Link 4 = B Link 6 = B

When the drive is used as a torque amplifier, turn the Time Constant control fully CW and the Damping control fully CCW.

Polarity of the 'Disable' Input

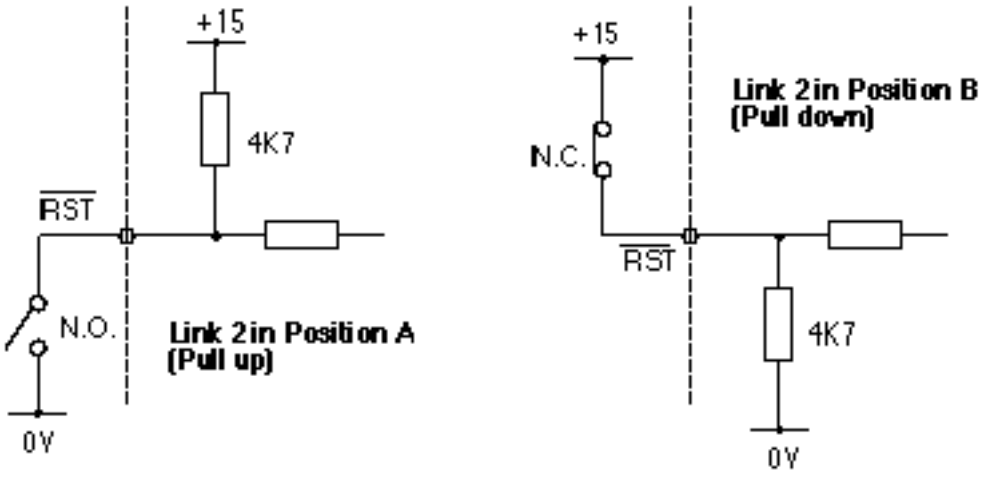


Figure 3-7. Reset/Disable Input Circuit Options

Jumper link 2 determines whether the internal resistor on the disable input is pulled up or down. In position A, the resistor is pulled up to +15V and the drive can be disabled by connecting the disable input to 0V using a switch or open-collector transistor. In position B the input resistor is returned to 0V, requiring a normally-closed switch up to +15V to keep the drive energised. The options are illustrated in Figure 3-7. The preferred 'fail safe' connection is with the link in position B, since the drive de-energises if the connection is broken.

The standard BLH drive is delivered with link 2 in position B, requiring that the reset input is connected to +15V to energise the drive.

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Encoder Resolution

With all standard motors, jumper link 3 should be left in position A. If the motor has been fitted with a non-standard encoder (available to special order only), and its resolution is greater than 1500 lines, transfer the jumper link to position B.

Standard encoder resolutions are 500 lines for size 16 and 23 motors, and 1000 lines for size 34 motors. After quadrature decoding these produce working resolutions of 2000 and 4000 counts/rev respectively.

Current Limit Setting

Jumper links 7, 8 and 9 are used to set the peak current which the drive will deliver. Table 3-9 shows the Jumper link settings for various peak current levels.

BLH30	BLH75	BLH150	7	8	9
7.5A	15A	30A	B	B	B
3.75A	7.5A	15A	B	B	A
2.5A	5A	10A	B	A	B
2A	3.75A	7.5A	B	A	A
1.5A	3A	6A	A	B	B
1.25A	2.5A	5A	A	B	A
1A	2A	4A	A	A	A

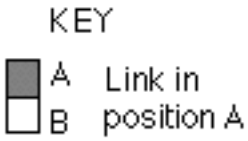


Table 3-9. Current Limit Link Settings

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It is normal to set the peak current at approximately 3 times the continuous current rating of the motor. The table below shows the recommended peak current setting for each motor size:

Motor	Peak Current	BLH30			BLH75			BLH150		
		LK7	LK8	LK9	LK7	LK8	LK9	LK7	LK8	LK9
ML1620	3.75A	B	B	A	-	-	-	-	-	-
ML2340	7.5A	B	B	B	B	B	A	B	A	A
ML3450	15A	-	-	-	B	B	B	B	B	A
ML3475	30A	-	-	-	B	B	B	B	B	B
Default		A	A	A	A	A	A	A	A	A

Table 3-10. Recommended Peak Current

You can use peak current settings higher than the values shown above provided you take great care not to exceed the appropriate duty cycle, otherwise you may burn out the motor. Also, if you make the motor go unstable during tuning, disable the drive immediately to prevent damage to the motor.

Tuning the Drive

The appropriate tuning procedure should be carried out on each axis. The procedures in this section assume that you have completed the connection and test procedures provided in Sections 2 and 3. The motor should be coupled to the load at this stage.

Tuning for use as a Velocity Amplifier

Use the following procedure to tune the drive.

Step 1

Set jumper links.

Step 2

Make sure the power to the drive is off and that the motor is held securely and the shaft is free to rotate.

Step 3

Adjust the front panel controls as follows:

TACH GAIN	Fully CW
DAMPING	Fully CCW
TIME CONSTANT	Fully CCW

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Step 4

Apply zero velocity demand to the input by connecting both signal inputs (VEL1 and VEL2) together.

Step 5

Switch on the power to the drive. Should the motor rotate, adjust the Balance potentiometer in the opposite direction to the motor rotation until stationary.

If any fault LEDs illuminate, refer to Section 5, "Maintenance & Troubleshooting".

Step 6

Set the velocity amplifier sensitivity by applying a signal of 20% of maximum input (2V for ±10V operation) and adjusting the Tach Gain 20-turn potentiometer to give 20% of maximum speed.

Step 7

Reduce the input signal to zero to stop the motor.

Step 8

Rotate the Time Constant control clockwise until the motor shaft starts to oscillate (characterised by a high-pitched ringing sound). Optimum drive performance is achieved at the point when the motor first starts to ring. Do not allow the motor to oscillate for more than a second or two.

Step 9

Increase the input signal to run the motor at high speed (**not full speed**) and check for smooth behaviour. If there is excessive noise or vibration, try turning the Time Constant control anti-clockwise.

Step 10

Periodically apply and remove short 20% velocity input signal pulses at approximately 1-second intervals. If the control system will not permit this method of control, remove the signal connections and use a separate DC power source (i.e., a battery or a DC power supply) to provide the signal.

Note the response of the system. The velocity may be monitored by attaching an oscilloscope probe to LK1 with the earth clip on pin 4 of the user I/O connector (15 way D-type pin 7 with respect to pin 4). The objective is to optimise the motor's responsiveness to the input signal. Adjust the Damping control to give the shortest settling time without overshoot and without sluggishness. Turning the control CCW makes the motor more responsive (stiff), and turning the control CW makes the motor more sluggish.

If the final speed changes considerably, you may want to change the velocity input signal to compensate. If the motor begins to oscillate (or oscillate louder than the setting derived from step 10) adjust the Time Constant control.

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Step 11

Remove the input signal and ground VEL1 and VEL2 to each other, and, if necessary, readjust the Balance control until the shaft remains stationary.

Tuning for use as a Torque Amplifier

Use the following procedure to tune the drive.

Step 1

Set jumper links.

Step 2

Make sure the power to the drive is off and that the motor is held securely and the shaft is free to rotate.

Step 3

Adjust the front panel controls as follows:

DAMPING	Fully CCW
TIME CONSTANT	Fully CW

In some torque amp applications it is necessary to set an accurate torque amp gain (i.e. Amps/Volt or Nm/Volt). This can be achieved by setting LK1 in position B and LK4 in position C. In this mode, the otherwise redundant TACH GAIN pot is used as a gain control.

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EMC Installation

It should be stressed that although these recommendations are based on the expertise acquired during the development of fully compliant products, and on tests carried out on each of the product types, it is impossible for Digiplan to guarantee the compliance of any particular installation. This will be strongly influenced by the physical and electrical details of the installation and the performance of other system components. Nevertheless it is important to follow *all* the installation instructions if an adequate level of compliance is to be achieved.

External enclosures

The measures described in these recommendations are primarily for the purpose of controlling conducted emissions. To control radiated emissions, all drives and rack systems must be installed in a steel equipment cabinet which will give adequate screening against radiated emissions. This external enclosure is also required for safety reasons. With the exception of drive front panels in rack-based units, there must be *no user access* while the equipment is operating. This is usually achieved by fitting an isolator switch to the door assembly. Packaged drives, transformers and filters must be mounted to a conductive panel. If this has a paint finish, it will be necessary to remove the paint in certain areas where specified.

To achieve adequate screening of radiated emissions, all panels of the enclosure must be bonded to a central earth point. The enclosure may also contain other equipment such as motion controllers, and the EMC requirements of these must be considered during installation. Always ensure that drives and rack systems are mounted in such a way that there is adequate ventilation.

Before mounting the drive, remove the paint from the rear face of the lower mounting lug as shown in Fig. 3-8 (if not already paint free), and if necessary from the corresponding area on the rear panel of the enclosure. This is to guarantee a good high-frequency low impedance connection between the drive case and the cabinet. Use petroleum jelly on the exposed metal to minimise the risk of future corrosion.

Where P-clips and mains filter modules are specified, they must achieve a good high frequency, low impedance, bond to the earth plane. The panels of the enclosure metalwork should also be bonded to the earth plane.

AC Supply Filtering

These recommendations are based on the use of proprietary mains filter units which are readily available. However, the full EMC test includes a simulated lightning strike which will damage the filter unless adequate surge suppression devices are fitted. These are not normally incorporated into commercial filters since the lightning strike test can be destructive. This test is normally carried out on the overall system and not on individual components, therefore the surge protection should be provided at the system boundary.

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Try to arrange the layout of transformer and filter so that the AC input cable is kept away from the filter output leads. It is preferable for the current path to be as linear as possible without doubling back on itself - this can negate the effect of the filter. Mount the filter within 50mm of the transformer, and run the input cable and any earth cables close to the panel. See Figure 3-9.

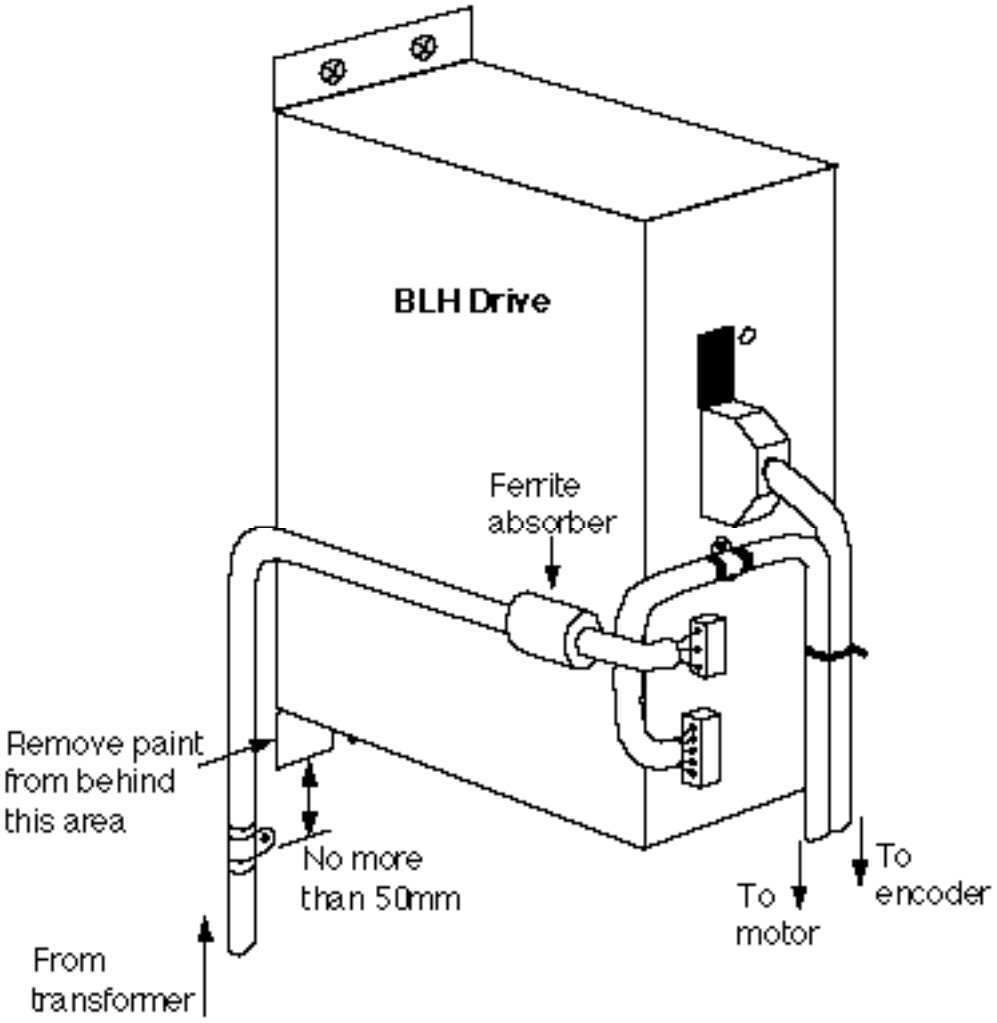


Figure 3-8. EMC Drive Installation

A filter must be installed between the incoming AC supply and the isolating transformer. A suitable filter is Corcom 10VV1. Mount the filter within 50mm of the transformer as shown in Fig. 3-9. Ensure that there is no paint on the mounting panel under the filter mounting lugs - it is vital that there is good large-area contact between the filter and the panel.

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Connect the incoming AC supply cable to the push-on terminals on the filter, with the earth lead connected to a local earth stud or bus bar. Route the supply cable so that it runs close to the walls of the enclosure. Connect the filter output terminals to the transformer primary, keeping the leads twisted together and as short as possible. Take an earth connection from the stud to the SCN terminal on the transformer, and run this lead close to the AC supply leads (see Fig. 3-9).

3-core 1.5mm^2 screened cable (with a braided screen) should be used between the transformer and the input to the drive. Use two cores for the output from the secondary winding and the third core for an earth connection from the stud. Run this cable back towards the mounting panel, expose a short length of the screen and anchor the cable close to the filter with a P-clip. When routing this cable to the drive, keep it well away from the input cable to the filter.

At the drive end, fit a ferrite absorber over the cable and connect the three cores to the drive power connector. Locate the absorber as close as possible to the connector using heat-shrink sleeving. Run the cable back under the drive, expose a short length of the braided screen and anchor to the same mounting panel as the drive using a P-clip. Keep this anchor point close to the drive and if necessary remove any paint from the mounting panel under the clip.

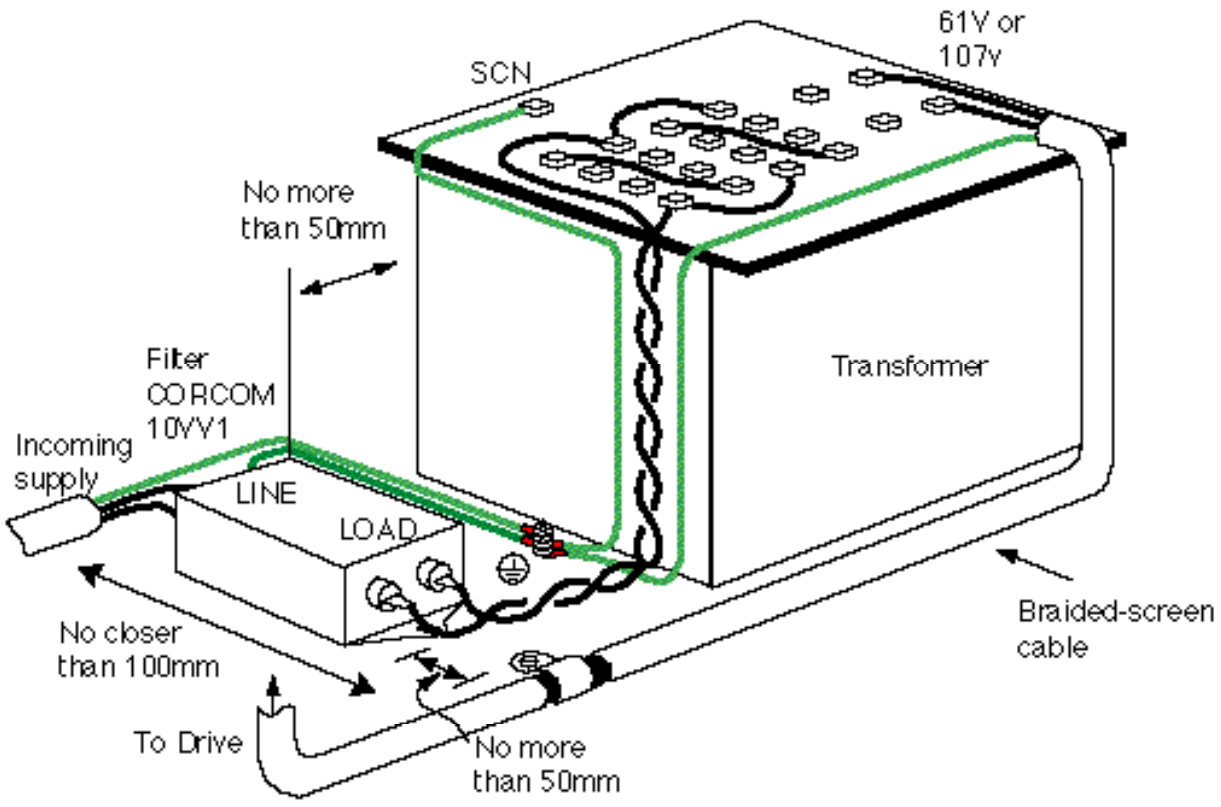


Figure 3-9. EMC Transformer Installation

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Motor and Encoder Connections

ML Series motors are being modified to accommodate EMC installation (ML2340,3450 and 3475). The modifications include changing the encoder cable to a braided-screen type and fitting different glands to the terminal housing. If it is necessary to adapt an existing motor, the encoder cable should be changed to a 10-pair braided screen type (Lapp Part No. 0035805) and the terminal box glands changed to suit.

The standard 5-core motor cable fitted to the ML motor is retained. Expose a short length of the braided screen approximately 100mm from the drive connector, and use a P-clip to anchor the cable under the lower front panel screw as shown in the diagram. Run the cable underneath the drive to the rear panel. Note that the motor cable should be kept at least 300mm away from I/O cables carrying control signals.

When routing the cables to the motor, make sure that the motor and encoder cables are kept close together throughout their whole length. Unless the cables are laid alongside each other in trunking, use cable ties every 500mm to anchor the two cables together.

Ferrite absorber specifications

The absorbers described in these installation instructions are made from a low-grade ferrite material which has high losses at radio frequencies. They therefore act like a high impedance in this waveband.

The recommended components are produced by Parker Chomerics and are suitable for use with cable having an outside diameter up to 10mm. The specification is as follows:

Chomerics part number	H8FE-1115-NC
Outside diameter	17.5mm
Inside diameter	10.7mm
Length	28.5mm
Impedance at 25MHz	80Ω
Impedance at 100MHz	120Ω
Curie temperature	130°C (the device should not be operated near this temperature)

Handling and installing the ferrite absorbers

Take care when handling the absorbers - they can shatter if dropped on a hard surface. For this reason the suggested method of installation is to use a short length of 19mm diameter heat-shrink sleeving. This gives a degree of physical protection while the cable is being installed. The sleeving should have a shrink ratio of at least 2.5:1. Cable ties may be used as an alternative, however they give no physical protection to the absorber.

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Section 4. HARDWARE REFERENCE

BLH Drive Specification

	BLH30	BLH75	BLH150
Continuous Current	3.75A	7.5A	15A
Peak current	7.5A	15A	30A
DC bus Voltage	85V	150V	150V
AC Input Voltage: Nom. Max. Min.	61V 67V 24V	107V 118V 48V	107V 118V 48V
Weights kg (lb)	2.9 (6.4)	3.9 (8.6)	5.4 (11.9)
Motor Options	ML-1620, ML-2340	ML-2340, ML-3450	ML-3450, ML-3475
Power input	Isolated AC direct from mains transformer		
Control input	±10V analogue (torque or velocity)		
Reference outputs	±15V at 10mA		
Velocity feedback	Built-in incremental encoder		
Commutation method	4 bit absolute encoder		
Torque amplifier bandwidth	>2500Hz		
Switching frequency	20Khz		
Velocity amp gain	0.66/6.6/51/500/4800 set by links		
Typical continuous input power	2.5A @ 61V	6A @ 107V	11A @ 107V
Max. input power (peak only)	7A @ 61V	14A @ 107V	28A @ 107V
Torque amp gain	0.75/0.075AV	1.5/0.15AV	3/0.3AV
Gain linearity	±4%		
Typ. input amp drift	10µV/°C		
Power dump current	9A @ 100V	16A @ 100V	16A @ 100V
Max. cont. dump power	40W		
Min recommended load inductance	0.5mH		
Jumper link settings	Input range, current limit, torque/vel. mode		
Potentiometer settings	Time constant, damping, balance, tach gain		
Diagnostic LED's (Front)	Power on, current limit, overtemperature, drive/motor fault		
Diagnostic LED's (Rear)	Power on, composite fault		
Dimensions	See Figure 3-1 (Section 3)		

Table 4-1. BLH Servo Drives Specification

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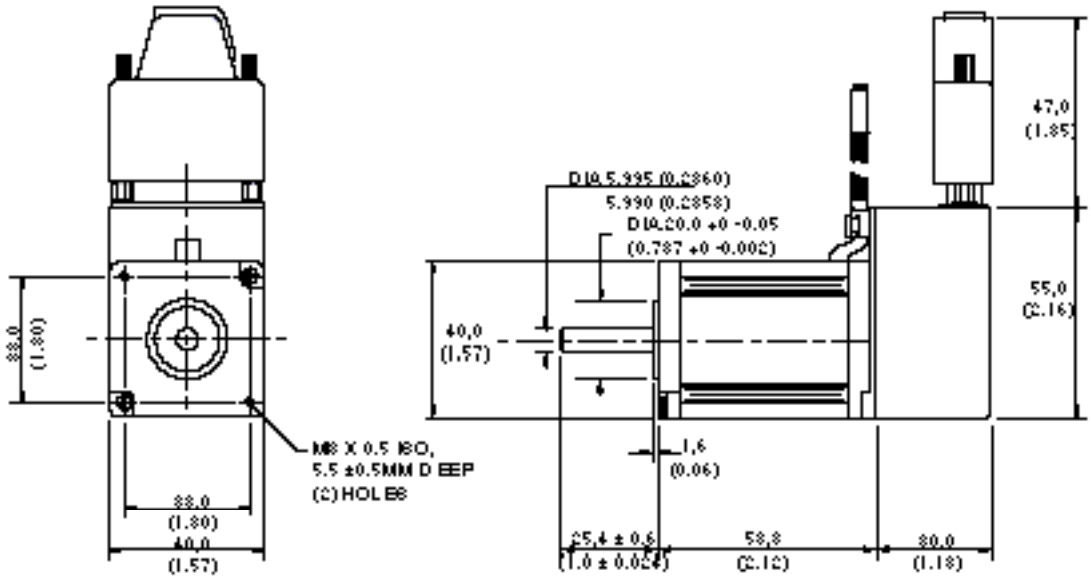
Brushless Motor/Drive Packages

The BLH Series drives may be matched with motors in the Digiplan brushless range and supplied as ready-wired motor/drive packages. Details of the range of four motors (Types ML-1620, ML-2340, ML-3450 and ML-3475) are given in Table 4-2.

Type	Weights (including cable)	Rotor Inertia Kg-cm^2	Incremental Encoder Line Count
ML-1620	0.85Kg	0.056	500
ML-2340	2.1Kg	0.28	500
ML-3450	5.1Kg	1.6	1000
ML-3475	6.4Kg	2.4	1000

Table 4-2. Brushless Motor Data

The dimensions of the motors are shown in Figures 4-1 to 4-3.



Note: The ML1620 motor should only be used with the BLH30 drive.

Figure 4-1. Motor Type ML-1620 Dimensions

CAUTION - high temperatures

The motor case will exceed 85°C before the motor overtemperature trip operates.

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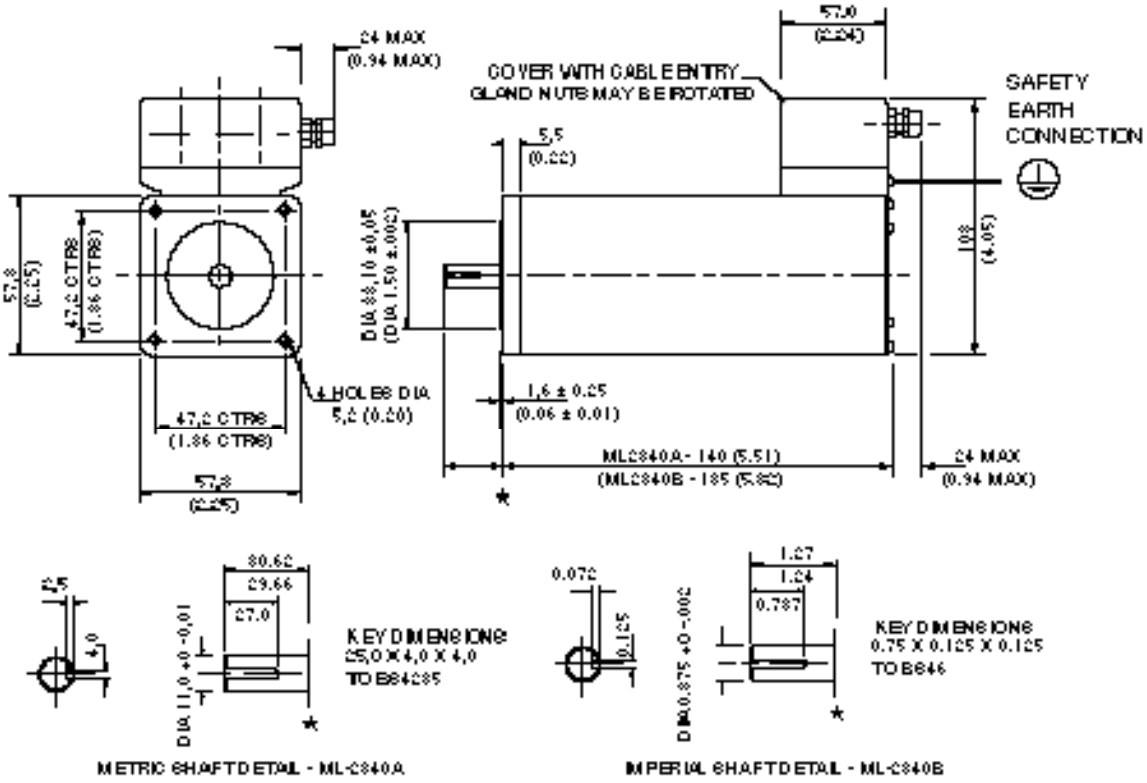


Figure 4-2. Motor Type ML-2340 Dimensions

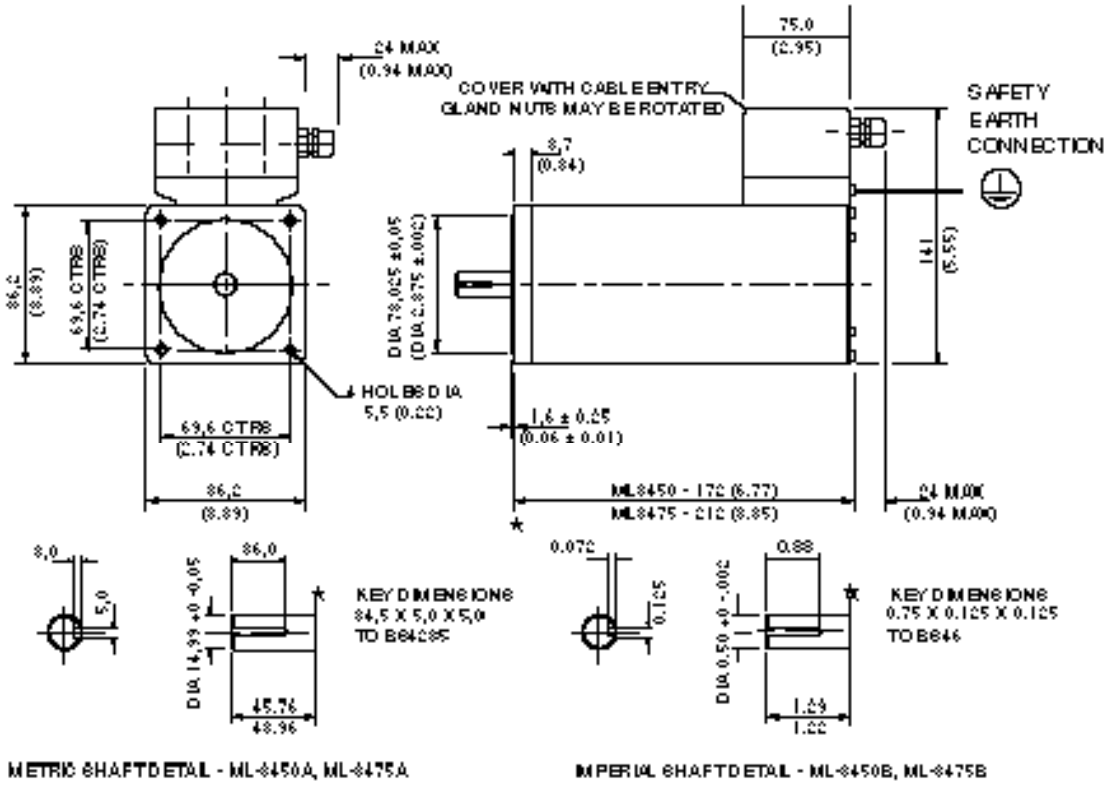


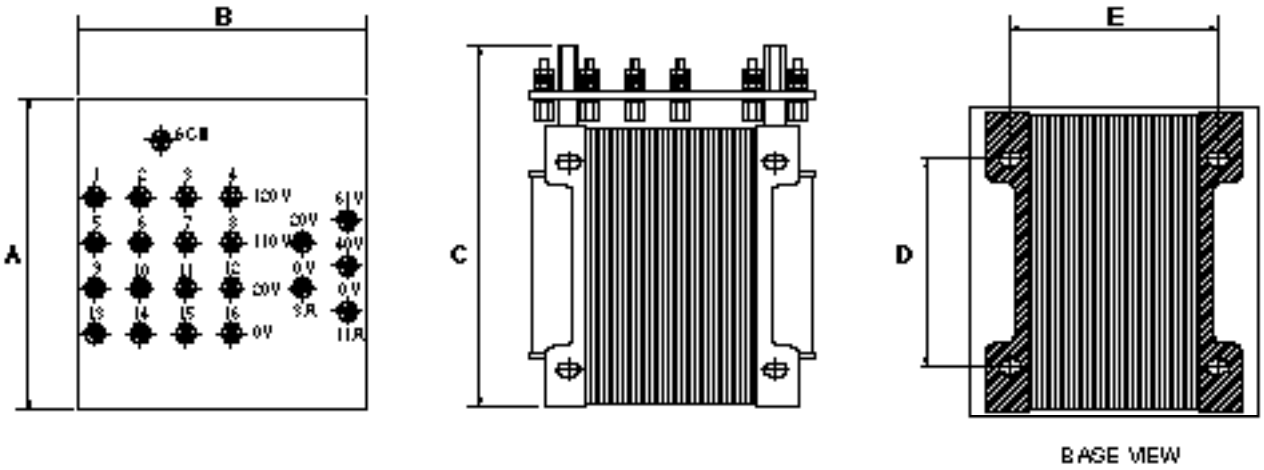
Figure 4-3. Motor Type ML-3450 & ML-3475 Dimensions

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Safety Earth

The resistance to the main earth star point should be less than 0.1Ω. Use a ring terminal secured directly against the motor body.

Transformer Dimensions



Dimensions	T092	T0170	T0171
A	136.0 (5.35)	195.0 (7.68)	215.0 (8.47)
B	126.0 (4.96)	135.0 (5.32)	172.0 (6.77)
C	155.0 Max. (6.10 Max.)	215.0 Max. (8.47 Max.)	242.0 Max. (9.53 Max.)
D	89.0 (3.50)	102.0 (4.02)	115.0 (4.53)
E	89.0 (3.50)	82.0 (3.23)	110.0 (4.33)
Weight	8Kg	15.5Kg	24.5Kg

Figure 4-4. Transformer Dimensions

CAUTION

Take particular care when lifting larger transformers. Do not lift by the terminal plate or cover, as these could break.

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Motor/Drive Package Performance Data

The torque curves for the possible motor/drive combinations are shown in Figure 4-5.

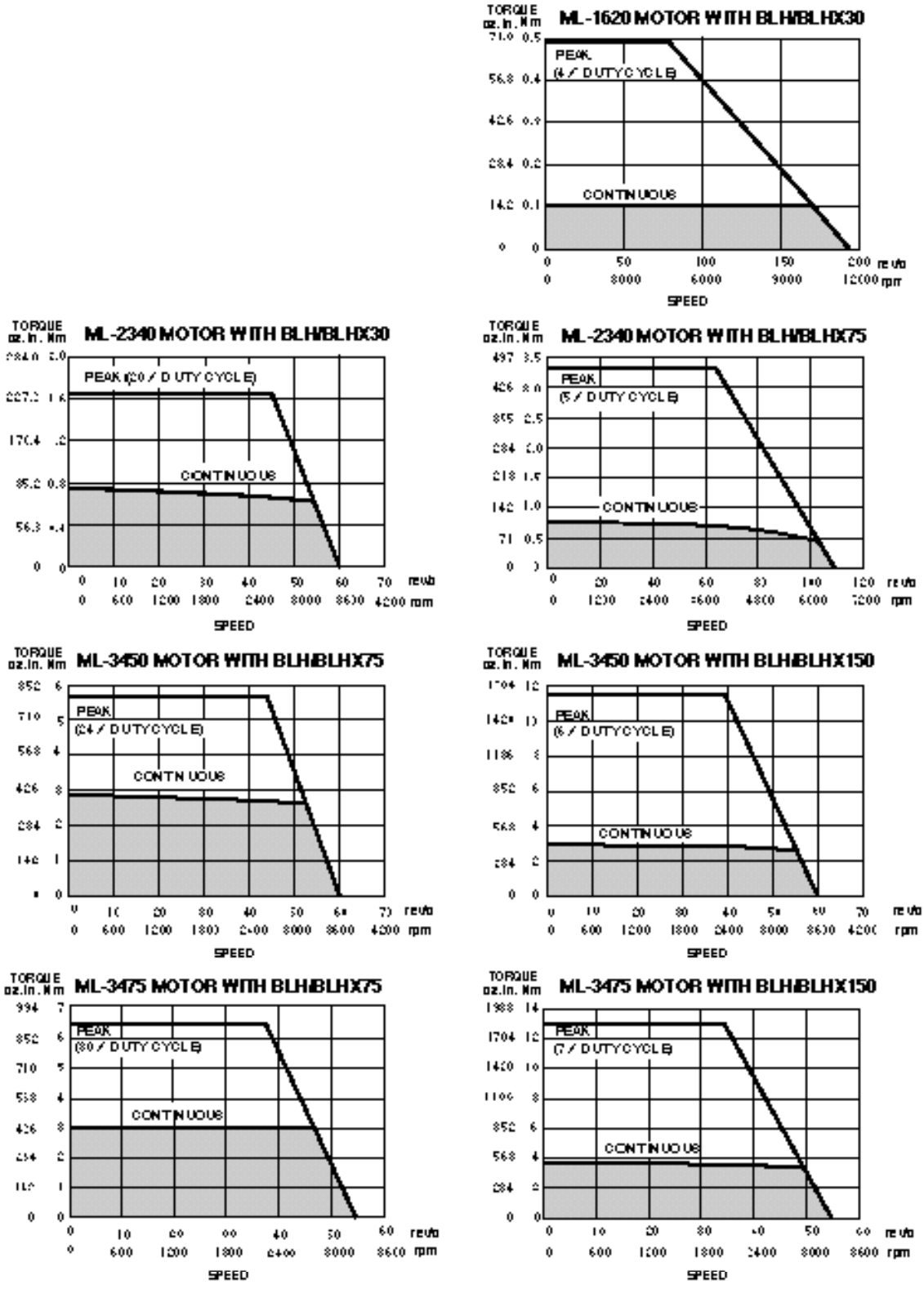


Figure 4-5. Motor/Drive Packages Torque Curves

Fuse Ratings

BLH drives incorporate four fuses - two AC input fuses, a DC bus fuse and a power dump fuse. Types and ratings are shown in Table 4-3.

			Rating		
Fuse No.	**Circuit**	**Type**	**BLH30**	**BLH75**	**BLH150**
FS1	AC input	32mm TL HBC	8A	15 or 16A	30 or 32A
FS2	AC input	32mm TL HBC	8A	15 or 16A	30 or 32A
FS3	DC bus	32mm QA HBC	8A	10A	20A
FS10	Power dump	20mm TL LBC	2A	2A	2A

TL - Time lag
QA - Quick acting
HBC - High breaking capacity
LBC - Low breaking capacity

Table 4-3. BLH Fuse Ratings

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Motor Wiring

Earlier versions of motors were wired as shown in Figure 4-6.

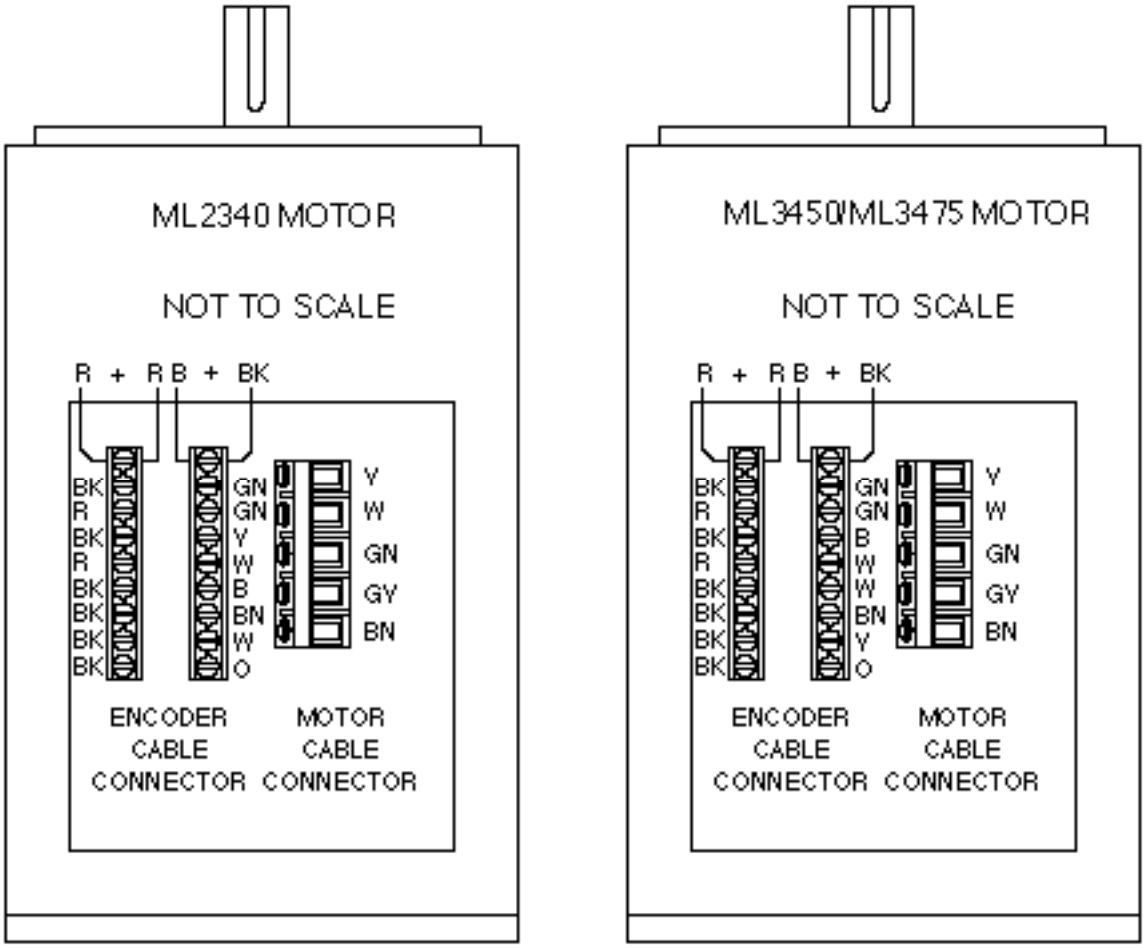


Figure 4-6. Motor and Encoder Connections at the Motor

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ML Motor PCB

Later versions of the ML motors will have a silkscreen PCB as shown in Figure 4-7. Refer to Tables 4-6 and 4-7 which detail the encoder wiring required for the ML2340 and ML3450/ML3475 motor types fitted with the PCB.

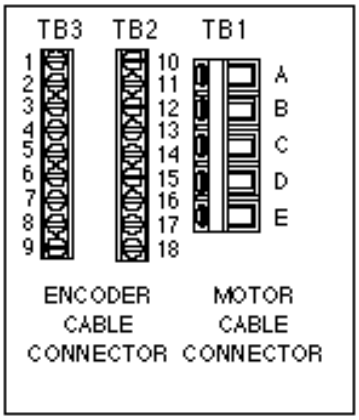


Figure 4-7. Motor PCB Silkscreen

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ML2340 Encoder Connections

Motor connector number (TB3 & TB2)	Motor feedback connector number (25-way D-type)	Original colours for ML2340	New colours for ML2340
1	3 & 16 (+5V)	red + red	red + violet
2	20 (*A2)	black	white/grey
& 11	21 (A2)	green	grey/brown
3	6 (*MOT)	red	grey
& 12	7 (MOT)	green	pink
4	24 (*A0)	black	white/green
& 13	25 (A0)	yellow	brown/green
5	8 (Z-)	red	yellow/brown
& 14	9 (Z+)	white	white/yellow
6	22 (*A1)	black	white/pink
& 15	23 (A1)	blue	pink/brown
7	12 (A-)	black	white
& 16	13 (A+)	brown	brown
8	18 (*A3)	black	red/blue
& 17	19 (A3)	white	grey/pink
9	10 (B-)	black	yellow
& 18	11 (B+)	orange	green
10	2 & 15 (0V)	black + blue	black + blue

* indicates the inverse of the signal.

Table 4-6. ML2340 Motor Encoder/Drive Connections

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ML3450/ML3475 Encoder Connections

Motor connector number (TB3 & TB2)	Motor feedback connector number (25-way D-type)	Original colours for ML3450 & ML3475	New colours for ML3450 & ML3475
1	3 & 16 (+5V)	red + red	red + violet
2	20 (*A2)	black	white/grey
& 11	21 (A2)	green	grey/brown
3	6 (*MOT)	red	grey
& 12	7 (MOT)	green	pink
4	22 (*A1)	black	white/pink
& 13	23 (A1)	blue	pink/brown
5	8 (Z-)	red	yellow/brown
& 14	9 (Z+)	white	white/yellow
6	18 (*A3)	black	red/blue
& 15	19 (A3)	white	grey/pink
7	12 (A-)	black	white
& 16	13 (A+)	brown	brown
8	24 (*A0)	black	white/green
& 17	25 (A0)	yellow	brown/green
9	10 (B-)	black	yellow
& 18	11 (B+)	orange	green
10	2 & 15 (0V)	black + blue	blue + black

* indicates the inverse of the signal.

Table 4-7. ML3450/ML3475 Motor Encoder/Drive Connections

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ML1620 Encoder Connections

Figure 4-8 shows the ML1620 encoder connections at the drive and motor end of the multi-way cable. If you need to re-make this cable to allow routing through panels etc. the drive end connector should be removed in preference to the motor end connector.

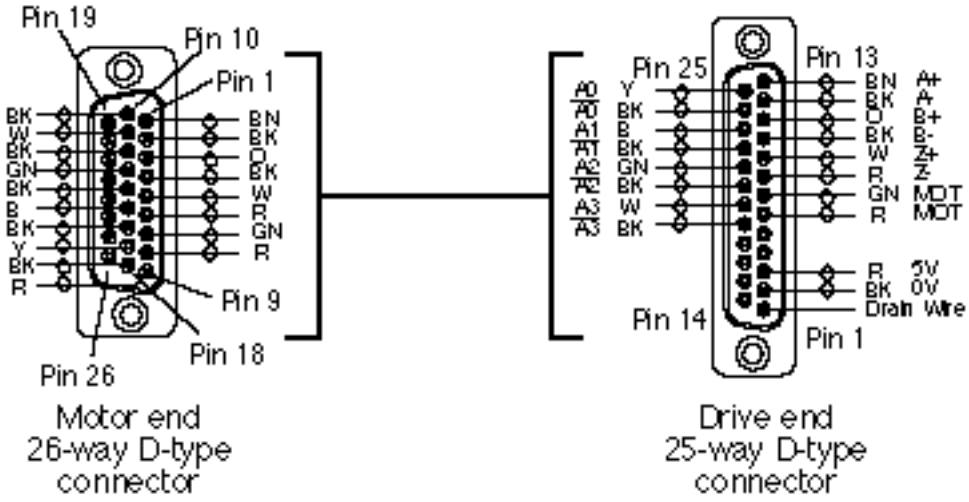


Figure 4-8. ML1620 Encoder Connections

Note: The ML1620 motor should only be used with the BLHX30 drive.

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Section 5. MAINTENANCE & TROUBLESHOOTING

General

In order to minimise field failures, all drives are soak tested at elevated temperatures. In spite of this the occasional failure may still occur and the following notes are intended as a brief guide to enable the cause of the fault to be located.

Take care, unexpected motion may occur at any time whilst troubleshooting motion control equipment.

Repairs

Whenever possible units should be returned to the manufacturers for repair, since automatic test equipment not available in the field is used when testing these drives. All repairs are soak tested before being returned to the customer.

Drive Removal

Before disconnecting a drive prior to removal, ensure that all supplies are switched off and wait for the Power On LED to go out.

Drive Fault LED

The majority of faults that can occur in the drive will result in illumination of the Drive Fault LED. The causes of this are as follows:

1. HT Overvoltage

Failure of the dump circuit to cope with regeneration. Check the dump fuse, FS4. Check if the fault occurs during a period of deceleration, if so, then consult Digiplan with a view to increasing the dump capability. If when the motor is stationary the DC supply normally has a value of more than 165V then there is a danger of the overvoltage protection operating under average regeneration conditions. Lowering the normal operating value of the supply may well cure this apparent fault.

2. Overcurrent

The drive fault LED will also be illuminated in the event of a short circuit occurring between the motor terminals or if either terminal is shorted to earth.

If no external reason can be found, switch off the supply, then remove the associated motor connections. Switch on the supply. If the fault LED is now illuminated then the drive is at fault and should be returned for repair. It may be necessary to request motion in either direction to obtain the fault.

3. Loss of Incremental Encoder Signal

The LED will be illuminated if the signal from the incremental encoder is not present. The motor would run away out of control if this was not detected.

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If previous tests have not enabled the fault to be isolated, then substitution of the drive (if possible) should enable the fault to be narrowed down to one drive which can then be returned for repair.

Overtemperature LED

This LED indicates an overtemperature fault. It may be the result of a drive fault, which can of course be proven by substitution. If this does not identify the fault then checks should be made to ensure that the ambient temperature does not exceed 40°C, when all units in the vicinity of the drive have reached their normal operating temperature. A cooling fan may be necessary if high duty cycles are required. The LED may also indicate motor overtemperature.

Power On LED

This LED indicates that the logic supplies are present. It will remain illuminated for a short time after the drive has been switched off, due to the stored charge in the capacitors.

Incorrect Operation

Noise from Motor or Unstable Motor Operation.
This is usually caused by the Damping or Time Constant controls requiring adjustment. Re-adjustment of either of these two controls should cure this. If none of these checks has isolated the problem then substitution of the drive should be used (if possible) to prove whether or not the drive module is at fault.

Motor Creep

This is usually caused by an incorrect setting of the Balance control, so first check this setting by confirming that there is zero velocity command on V1 and V2 inputs. Then adjust the Balance control until the motor shaft is stationary.

Ensure that all signals are supplied in twisted pairs or screened cables.

If none of these steps resolves the problem then, once again, try substitution of the drive module to prove if the drive is at fault.

Returning the System

Contact the Parker Automation Technology Centre or the machinery manufacturer who supplied the product. Equipment for repair should NOT be returned directly to Digiplan without prior authorisation. Repairs will be carried out by Digiplan but will be processed via your supplier.

Digiplan may at their discretion authorise direct shipment to and from Poole or Rohnert Park, but only by prior arrangement with your supplier. Existing UK and USA customers who purchase equipment directly from Digiplan should contact Poole or Rohnert Park for further information (contact numbers are at the front of this User Guide).

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Appendix A

Fitting Longer Cables

When you order an ML motor, you can specify cable lengths up to 75 feet (22.5 metres). If possible, it is better to order the motor with the required cable length rather than try to extend it afterwards. If you need cables longer than 75 feet, you can make your own up to a maximum of 300 feet (90 metres) provided you follow the guidelines below.
Note: extending cables as described here will degrade EMC performance of the system, by reducing the effectiveness of screen connections.
Motor cables can be lengthened by simply replacing the cable with a longer one using the standard cable as a pattern. It should have 5 cores with an overall screen. Use 1 mm^2 (or 16 AWG) cores with a 2340 motor, and 1.5 mm^2 (or 14 AWG) with a 3450 or 3475.

The 1620 motor is pre-wired with 4-core cable, so it is only necessary to use 4-core screened cable when extending the lead.

Recommended Cable Sizes

Motor Frame Size	Motor Cable	
	<100ft	100-300ft
16	0.5mm^2 20 AWG 4-core	0.75mm^2 18 AWG 4-core
23	0.75mm^2 18 AWG 5-core	1mm^2 16 AWG 5-core
34	1.5mm^2 14 AWG 5-core	1.5mm^2 14 AWG 5-core

Table B-1. Motor Cable Sizes

Feedback Cables

The feedback cable may be extended up to a maximum of 50 feet (15 metres) using the same type of cable as that supplied with the motor. Each conductor in this cable is 0.2mm^2 (24 AWG). This type of cable is unsuitable for longer lengths owing to the voltage drop in the 5-volt supply to the encoder.

Encoder cables can be up to 300 feet long before any noise problem is encountered, but it's important to consider the voltage drop in the 5V supply leads to the encoder. If the voltage at the encoder is too low, it can cause curious problems such as continuous illumination of the overtemperature LED. The encoder must have a minimum supply voltage of 4.5 volts

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and it draws a current of about 300mA. Thus the total resistance of the 5V and 0V wires must be less than about 1.7 ohms. When you calculate this resistance, remember to multiply the resistance per metre (or per foot) by twice the cable length.

Probably the easiest way to lengthen the encoder cable is to cut the existing cable close to the motor and again close to the drive, and to insert a new length of the same type of cable using in-line connectors or terminal boxes. Suitable cable types are Lapp 0035805, Cablemaster OS1024P and Belden 9510. Try to keep the two wires in any pair close to each other as they pass through the terminal box. Remember to connect the screen of the new section to the screens of the two short lengths of original cable.

Having done this, now locate the red and black pair (which carry 5V and 0V) and run two larger wires in parallel with this pair between the two terminal boxes (e.g. Lapp 0034802 1 mm^2 screened). Each of these wires must have a resistance of less than 0.85 ohm. For example, use 1 mm^2 (or 16 AWG) cable for leads up to 150 feet (45m) long, and 2.5 mm^2 (or 14 AWG) cable for leads up to 300 feet (90m) long.

Inserting in-line connectors

It is sometimes necessary to be able to disconnect the motor easily, and a convenient solution is to fit in-line connectors. Generally the closer the connector is to the motor the better. Here are the part numbers for suitable MIL Spec connectors from Amphenol:

19-way Encoder Connectors	62GB-11F14-19PN	62GB-16F14-19SN
5-way Motor Connectors	62GB-11F14-05PN	62GB-16F14-05SN
8-way Motor Connectors	62GB-11F16-08PN	62GB-16F16-08SN

The connector shown above for the encoder cable has 19 pins; the 19th pin is used for the drain wire, i.e. the connection to the cable screen. If the connectors are within 500mm (18”) of the motor, you can use a 5-way connector in the motor cable and leave the screen unconnected. In other cases, use the 8-way (which is a larger shell size) and use pin 6 to link the screens on either side of the connector. Do not connect the screen or drain wire to 0v.

Take great care to make sure that both connector halves are wired correctly, otherwise the encoder or drive may be damaged. If the encoder cable has 10 pairs, the red and blue pair should be connected in parallel with the red and black pair (i.e. red parallel with red, blue parallel with black).

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Proprietary Cable Types

Motor Size	No. of cores	mm^2	ODmm	Lapp	Belden	Alpha
16	4	0.5	7.0	0034 604		
16	4	0.5	6.0			5464C
16	4	0.75	6.0		9418	
23	5	0.75	8.2	0034 705		
23	5	1.0	9.0	0034 805		
23	6	1.0	8.9			5366C
23	6	0.75	7.8			5386C
34	5	1.5	9.9	0034 905		
34	5	1.5	13.2			5450/5

Table B-2. Motor Cable Types

No. of cores	mm^2	ODmm	Lapp	Cable-master	Belden	Alpha	National
10 x 2	0.2	9.7		OS10P24	9510		
10 x 2	0.25	10.1	0035805				
10 x 2	0.5	11.8					NQP-1020FSJ
12 x 2	0.75	16.8				2249/12C	
12 x 2	0.75	14.0					NQP-1218FSJ

Table B-3. Feedback Cable Types

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