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CE

PKH Series Drive
User Guide

(for PKH65M & PKH130M Drives)

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Part No: 1600.048.05 February, 1997

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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 complete installation to comply with the Low Voltage Directive or 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 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.

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 a manner that does not conform to the instructions given in this User Guide, the protection provided by the equipment may be impaired.

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User Guide Change Summary

The following is a summary of the primary changes to this user guide since the last version was released. This user guide, version 1600.048.05, supersedes version 1600.048.04.

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 chapter is changed, the change bar is located on the outside margin of the chapter title.

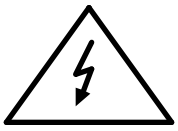
Major changes introduced at revision 04 are:

LVD compliance information has been added.

Warning symbols used on Digiplan drives have the following meanings:


Refer to the accompanying documentation


Protective conductor terminal

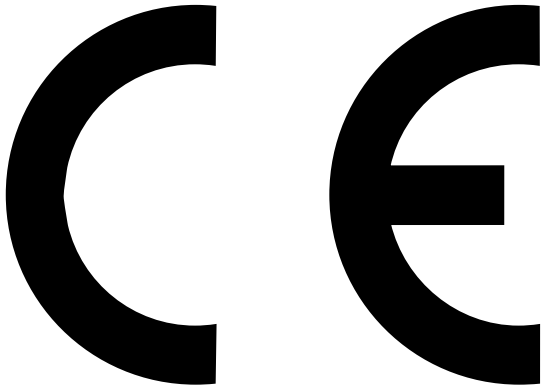

Risk of electric shock


Alternating current


Hot surface


Frame or chassis terminal

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Product Type: PKH65M, PKH130M

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

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

The PKH Series of drives are sold as complex components to professional assemblers, as components they are not compliant with Electromagnetic Compatibility Directive 89/336/EEC.

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Chapter 1. INTRODUCTION

Product Description

The PKH Series are complete packaged drive systems offering high standards of performance for medium and high-power applications. Both the PKH65M and PKH130M provide full and half-step operation as well as 1000 and 2000 steps/rev step resolution, with a nominal motor current rating of 6.5A for the PKH65M, and 13A for the PKH130M.

The PKH Series Drive is a bi-polar chopper regulator that provides full protection against short circuits (phase-to-phase and phase-to-ground). An integral power dump absorbs regenerated power during deceleration. Logic supply and heat sink temperature are monitored to prevent damage caused by brownout or over temperature.

Each model incorporates optical isolation on all signal inputs and outputs, allowing direct operation from 120VAC in the USA, although the use of a mains isolating transformer is recommended.

To meet EU Low Voltage Directive (LVD) requirements an isolating transformer must be used.

Operation from AC mains supplies other than 120V AC will automatically require the use of an external transformer, details of which can be found in Chapter 2 (Installation). To obtain full high-speed torque, the PKH65M/130M requires an external transformer that delivers 172VAC. Standard transformers are available which allow the drive to operate from supply voltages between 100 & 480VAC.

The integral cooling fan and logic supply of the drive operates from 120VAC, which needs to be supplied via a separate secondary transformer winding.

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Drive Features

Features of the PKH Series Drives are as follows:

- Fully packaged fan-cooled drive with integral power supply and heat sink
- Operates directly from 120VAC without an external transformer (USA only); optional transformer allows operation between 100 & 480VAC and provides maximum speed/torque performance
  Note: A transformer is recommended, even in the USA.
- Protected against brownout, over temperature, and short circuit (phase-to-phase and phase-to-ground)
- Compact high-powered drive (13.5" x 5.0" x 11.0")
- DIP switch-selectable 200 or 400 step/rev resolution with additional resolution selections of 1,000 or 2,000 steps/rev
- DIP switch-selectable motor current up to 6.5A (PKH65M) or 13A (PKH130M)
- Standby circuit reduces motor current by 50% at standstill
- Anti-resonance circuit for smoother low-speed operation
- Boost provides up to 30% more torque during acceleration
- LED status and diagnostic indicators

What You Should Have

Upon receipt, you should inspect your PKH Series Drive System for obvious damage to its shipping container. Report any damage to the shipping company as soon as possible. Digiplan cannot be held responsible for damage incurred during shipment. Carefully unpack and inspect your PKH65M/130M System. The items listed in Table 1-1 should be present and in good condition.

Ship Kit Table

Part Description	Part Number
Possible drives: PKH65M PKH130M	 PKH65M PKH130M
8-pin screw terminal connector	0405.378
PKH Series Drives User Guide	1600.048.XX

In the USA PKH130M drives supplied complete with motor will include jumper to allow motor rewiring and a motor cable.

Table 1-1. PKH Series Ship Kit

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Chapter 2. INSTALLATION

Installation

The PKH Series of drives are not EMC compliant, they are sold as a complex component for use by professional assemblers of motion control systems. They must be installed by competent personnel familiar with the installation, commissioning and operation of motion control equipment.

This Chapter provides you with the information required to physically install a drive and to set it up in a manner to best suit its use. Mains transformer information is also provided.

Physical Installation

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.

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 must be provided in the final installation, in accordance with LVD requirements.

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

Setting Drive Functions

The PKH Series Drives are shipped factory-set for optimum performance in the vast majority of applications. However, you may need to alter the drive DIP switch settings to accommodate your application's requirements.

The 10-position DIP switch is located on the drive front panel (see Figure 2-1). The functions and default settings of each switch are identified in Table 2-1.

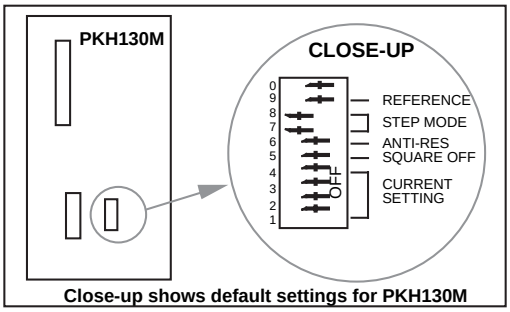


Figure 2-1. Drive DIP Switch Location

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DIP Switch	Function	Default Settings PKH65M/130M
1 through 4	Current settings	all OFF
5	Square-off	OFF
6	Anti-resonance	OFF
7 and 8	Resolution	both ON
9	Reference source	OFF
0	*not used*	OFF

Table 2-1. Drive DIP Switch Functions

Motor Current Selection (Switches 1 - 4)

The PKH is shipped with the current set to a maximum of 6.5A for the PKH65M and 13A for the PKH130M. Refer to Table 2-2 for other current settings.

The values shown in the table are two-phase-on levels. The current is approximately 35% greater on intermediate steps in the half-step mode when only one winding is energised. This gives a similar electrical power into the motor. The currents shown are nominal values, dependent upon motor inductance.

Under normal circumstances, the current setting should not be greater than the motor's current rating. However, *remember that the drive reduces the motor current by approximately 50% at standstill*. Therefore, if the duty cycle permits, it may be possible to operate at currents somewhat higher than the motor rating. In any event, care should be taken to avoid overheating the motor. The lowest current setting which gives an adequate torque margin is preferred.

DIP Switch Settings 1	2	3	4	Motor Current for PKH65M	Motor Current for PKH130M
OFF	OFF	OFF	OFF	6.5A	13A
ON	OFF	OFF	OFF	6A	12A
ON	ON	OFF	OFF	5.5A	11A
OFF	OFF	ON	OFF	5A	10A
OFF	ON	ON	OFF	4.5A	9A
OFF	OFF	OFF	ON	4A	8A
ON	ON	OFF	ON	3.5A	7A
ON	ON	ON	ON	3A	6A

Table 2-2. Optional Motor Current DIP Switch Settings

Current Profile

In the half-step mode, a two-level current profile is used at low speeds to equalise torque on alternate steps. Figure 2-2 illustrates this current profile with A and B representing the two-phase-on condition, and C representing the one-phase-on condition. When

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two phases are energised, the maximum current level for the PKH130M is 13A (6.5A for the PKH65M). This current level is increased in the one-phase-on condition to 18A (9A PKH65M) to help maintain the torque during intermediate steps.

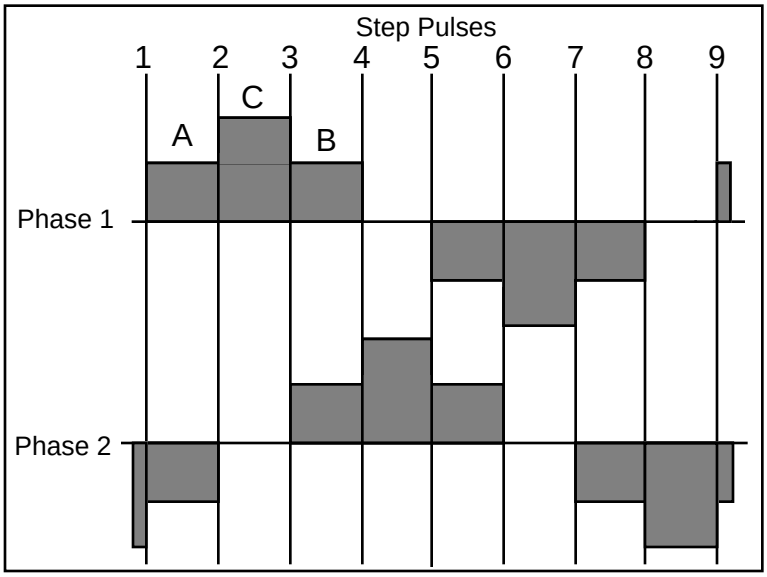


Figure 2-2. Normal Current Profile (Half-step Mode)

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Square-off (Switch 5)

The function of the square-off circuit is to maintain torque output in the middle speed range when motor current usually falls off due to winding inductance. Figure 2-3 illustrates the current profile squared-off to the one-phase-on level.

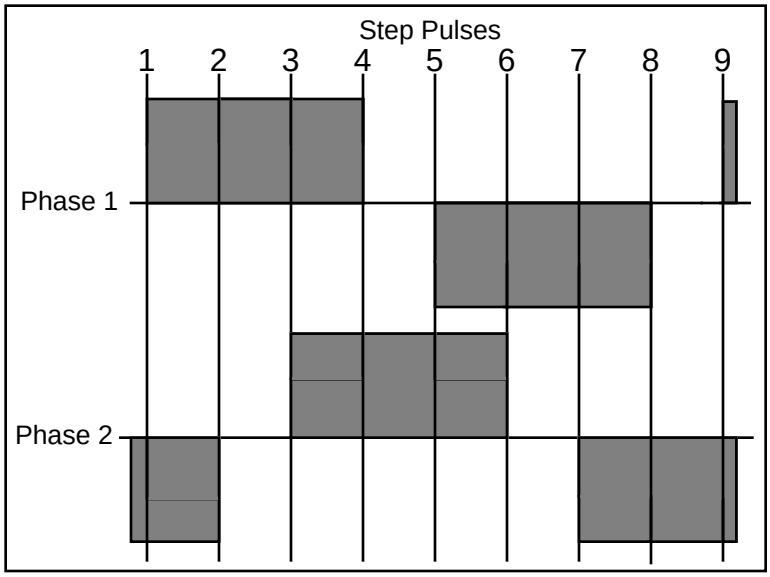


Figure 2-3. Current Profile with Square-off

Normally, you should leave this switch in the OFF position (default setting). The motor current will automatically *square off* to the one-phase-on level at approximately 1,600 full steps/sec (represented by the profile in Figure 2-2). This is the normal operating condition, and results in a useful increase in mid-range torque. Turning the switch ON causes the drive to square off permanently, increasing the average motor current at lower speeds. This will give greater low-speed torque. However, it will also increase both motor noise and motor operating temperature. The function should therefore be used with discretion, making sure the motor case temperature does not exceed 100°C (212°F).

Selecting permanent square-off (Switch 5 ON) in a mini-step mode effectively returns the drive to the full step current profile.

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Anti-Resonance (Switch 6)

This switch is normally in the OFF position. This allows the anti-resonance circuit to come into operation at speeds below 200 full steps/sec. Turning the switch ON disables the anti-resonance circuit and increases the low-speed torque at the expense of increased resonance. It is recommended you leave this switch in the OFF position, thereby reducing the chance of stalling the motor at low speeds. However the ON position may be preferable if the motor is heavily loaded.

Resolution Selection (Switches 7 & 8)

Use DIP switches 7 & 8 to select the desired motor resolution according to Table 2-3. Be sure to set the indexer to the same resolution. Consult your indexer user guide for instructions.

CAUTION

Do not change the resolution while power is applied to the drive.

Resolution (with 200 step/rev motor)	Stepping Mode	DIP Switch Settings 7	8
200 steps/revolution	Full step	ON	OFF
400 steps/revolution	Half step	OFF	OFF
1,000 steps/revolution	1/5 step	OFF	ON
2,000 steps/revolution*	1/10 step	ON	ON

* Default resolution setting for PKH65M/130M

Table 2-3. Resolution Settings

Reference Source (Switch 9)

DIP switch 9 is used to select the reference source for the current control system. The switch should be OFF.

Microstepping

Description

The PKH65M and PKH130M drives are fitted with the MS20 Microstep Card which gives improved resolution and smoothness from a standard motor. Microstepping is achieved by proportioning the currents in the two motor windings so that the rotor takes up a series of intermediate step positions. In this way a standard 200-step motor may be made to perform 1000 steps/rev (1/5 step mode), or 2000 steps/rev (1/10 step mode).

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Description (continued)

Ideally the intermediate current levels will produce equally-spaced step positions as well as equal dynamic torque, without exceeding the dissipation limit of the motor. In practice this can be difficult to achieve and a compromise has to be made. If the current levels are plotted against rotor position the resulting profile resembles a sinusoidal shape. The optimum profile varies from one type of motor to another, and for this reason the MS20 card has a selection of 64 alternative profiles which are stored in an Eprom and selected by an 8-position DIL switch. This switch is located between the two edge connectors on the drive module, and is accessible after the front panel has been removed (see Figure 3-2).

A sinusoidally-based profile is obtained with all bit switches in the OFF position. Switches 2 - 6 may be used to set in an increasing binary number which will cause the profile to progressively "fill out" from a sinewave (see Figure 2-4). Switch 2 is the least significant bit, switch 6 the most significant. By turning on switch 7, increasing the number in switches 2 - 6 will then trim the profile down towards a triangular shape. In practice this tends to be more useful than the "filled out" form. Switches 1 and 8 should be left permanently off.

A few examples are shown below in Table 2-4 - a "1" indicates that the switch is "on".

Switch position								Profile
8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	
0	0	0	0	0	0	0	0	Sinewave
0	0	0	0	0	0	1	0	Slight fill-out
0	0	1	0	0	0	0	0	Moderate fill-out
0	0	1	1	1	1	1	0	Maximum fill-out
0	1	0	0	0	0	1	0	Slight trimming
0	1	1	0	0	0	0	0	Moderate trimming
0	1	1	1	1	1	1	0	Maximum trimming

Table 2-4. Examples of Bit Switch Settings

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Setting Up the Microstep Card

Choosing the optimum profile for a given motor is best carried out with equipment which will accurately measure shaft position and torque. Since this is seldom available, empirical methods are normally used and can give perfectly acceptable results. The setting up should only be attempted when all connections have been made and the motor is running.

The logical starting point is with all switches off to give a sinusoidal profile. Attach a light pointer to the motor shaft (cable ties are ideal), and run the motor very slowly. It will be visually apparent whether the steps are all similar or there is a cyclic variation in step size as the shaft rotates. Slowly increase the speed, and the sound from the motor will give an idea of the relative torque produced on successive steps. Again a cyclic pulsing sound implies associated torque variations.

Switch off, remove the front cover and try setting a trimmed profile (see table above). Repeat the exercise and compare the results. From this it should be clear whether more or less trimming is required, so choose another setting and try again. It is usually best to aim for the smoothest rotation rather than best static positioning. If the application demands significant torque from the motor, repeat the exercise with the motor loaded. This method usually reveals the useful range of profiles quite quickly.

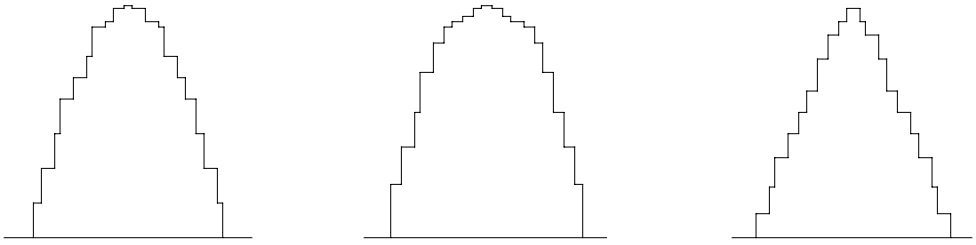


Figure 2-4. Microstepping Current Profiles

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System Connections

Be sure to read the following before operating the drive.

High voltages exist on the motor terminals. All motor connections should therefore be adequately insulated. Pay particular attention to any unused leads on the motor. If using a motor not supplied with a PKH Series system, unused motor leads should be separated and isolated.

WARNING

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

If you need to change fuses, always disconnect the power from the drive before removing the drive top panel and wait several minutes for high voltages to decay.

Wiring Recommendations

PKH Series drives use optical isolation on all control signal connections. This allows direct on-line operation at 120V in the USA and minimises sensitivity to electrical noise. Note however, that use of an isolating transformer is always recommended, and is essential in order to meet the safety standard chosen to demonstrate compliance with the Low Voltage Directive.

You should observe the following elementary precautions to guarantee trouble-free operation:

- Motor leads should be collectively shielded if they run close to power switching lines, particularly those driving unsuppressed inductive loads.
- Keep high-power connections, such as motor leads, separate and shielded from control signal connections. When it is necessary to run motor cables in the same conduit as control signals, the motor leads should be shielded separately. Connect the shields to ground at one end, and insulate them at the remote end.
- Ensure that the drive and motor are reliably earthed.

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Insulation rating of the secondary power connections and motor cables should be at least 1000V, where this is between power and signal circuits. Insulation requirements to mains wiring are higher and will be dependent upon environment and the local machine safety standards applied. Within secondary and motor circuits, and to earth, insulation rating of 600V is acceptable.

Flash Testing

For internal circuit protection reasons a varistor is fitted between the neutral and earth (ground) mains input wiring within the drive.

Important: If you wish to flash test the completed installation from mains to earth, it will be necessary to disconnect and insulate the live and neutral mains connections to the drive. Otherwise, the varistor will break down when the flash test is applied.

The earth connection and signal I/O should remain connected to the drive, in order to test the insulation of these circuits.

Direct AC Power Connections (USA only)

Important: Operation directly from the mains means that the drive will not meet the European Safety standard relating to the Low Voltage Directive. This can only be met if an isolating transformer is used.

The AC input must be taken both to the motor supply terminals L1 and L2 and to the terminals marked **115V AC IN**.

This mode of operation allows you to operate the PKH Series of Drives without an external supply transformer, where suitable mains supplies are available. However, this limits high-speed performance due to low available voltage.

If you wish to use a transformer rather than direct-on-line operation, see the next section for transformer connection details.

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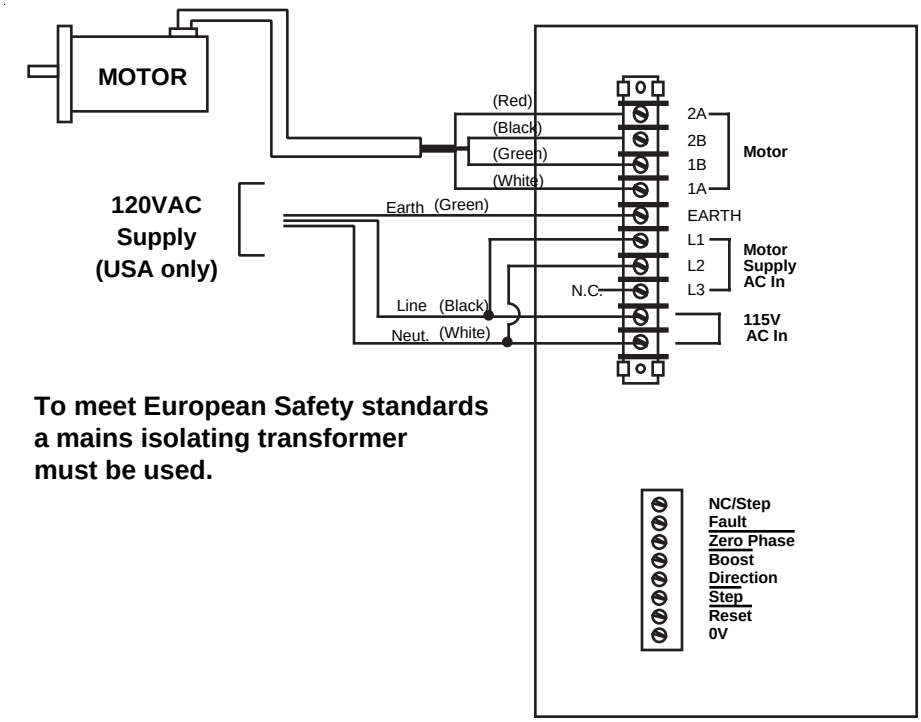


Figure 2-5. PKH Series System Connections - 120V AC supply (USA only)

WARNING - danger of electric shock

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

Transformer Connections

The Digiplan -T0124 transformer may be used to power the PKH130M Drive, and the T0132 may be used to power the PKH65M Drive. Transformer operation is necessary when the full high-speed torque is required and is always needed in countries other than the USA.

As illustrated in Figure 2-6, these transformers have a four-winding primary arrangement. The sample connection shown is the configuration for 120VAC. Figure 2-7 shows the connections for 240V AC. Table 2-5 identifies the optional primary connections for various AC input supply voltages.

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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.

CAUTION

Always wire the transformer primary first. Then check the secondary output voltages on open-circuit BEFORE connecting to the drive.

Be sure to connect earth ground to the **SCN** stud on the transformer and to the drive earth.

For mains wiring, use approved mains cable of at least 0.75mm^2 CSA (TO132) or 1.5mm^2 CSA (TO124), 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., 18-0-18V 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). The 115V 0.3A secondary is fused in the PKH drive.

The PKH130M may need all 14 amps available from the 172VAC outputs. This means that you will have to jumper these two outputs together as shown in Figure 2-6. Then wire these terminals to the PK130's L1 & L2 inputs. The PKH65M will only require a supply of 7 amps. You also need to wire 115VAC from the transformer secondary to the PKH65M/130M as shown.

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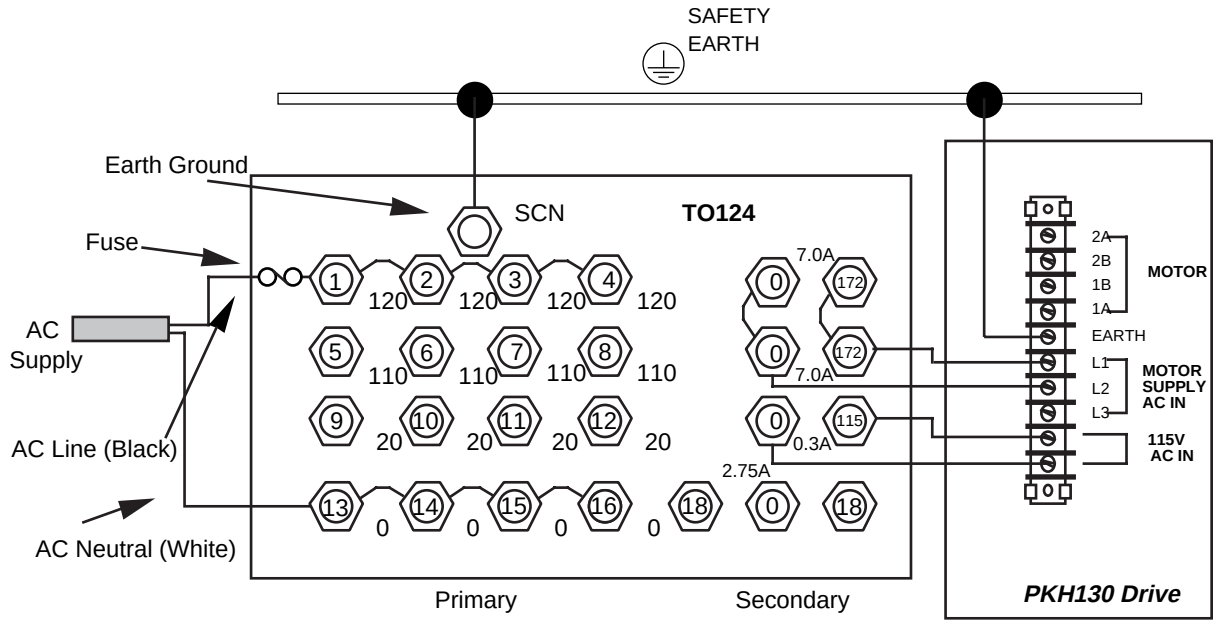


Figure 2-6. Transformer Wiring Configuration (Showing 120V AC Setting)

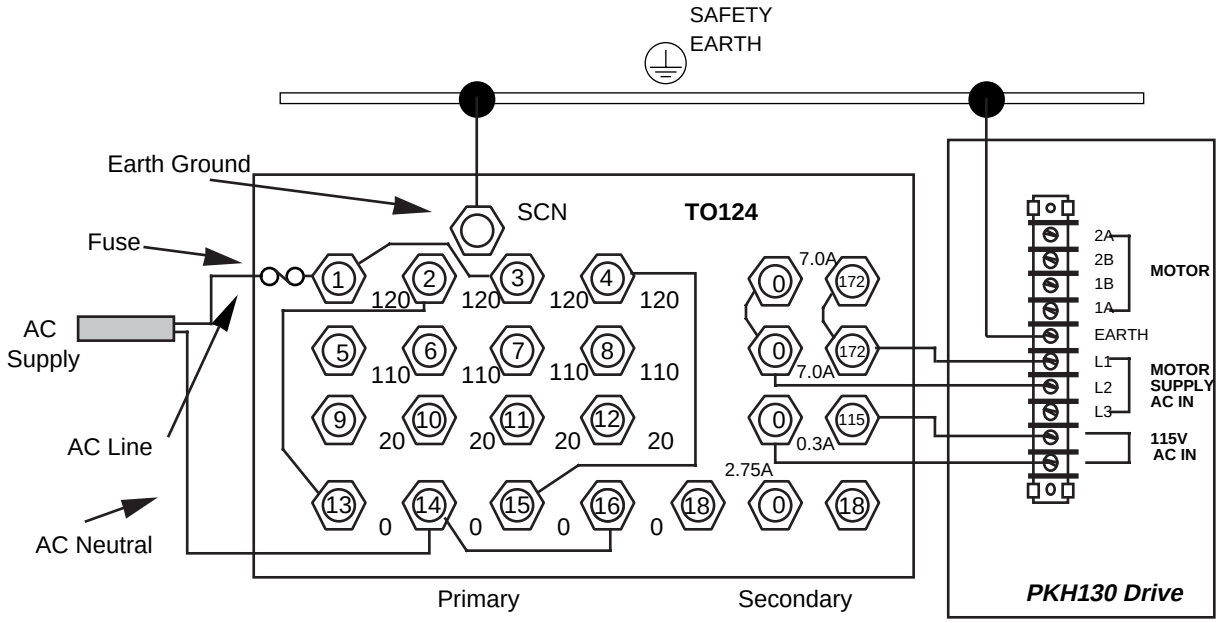


Figure 2-7. Transformer Wiring Configuration (Showing 240V AC Setting)

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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.

If the live wire cannot be readily identified, fuse both phase conductors.

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.

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Voltage Adjustment

Table 2-5 gives details of the terminal connections for the range of mains input voltages. Input voltages in the range 360 to 460V are for connection across two phases of a three phase supply.

Input Voltage	Connect AC Line to:	Connect AC Neutral to:	Connect Studs:
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 & 16; 15 & 8; 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 & 7; 15 & 8

Table 2-5. Optional Transformer Settings

CAUTION

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

Motor Connections

Consult Tables 2-6 & 2-7 or the motor manufacturer's wiring instructions to determine which motor wires correspond to Phase 1 and Phase 2.

After you determine the motor's wiring configuration, connect the motor leads to terminals 2A, 2B, 1A, and 1B as shown in Figure 2-8. Connect one phase of the motor to terminals 1A and 1B, and the other phase to terminals 2A and 2B. To reverse the direction of rotation relative to the direction control input, interchange the connections to 1A and 1B.

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The motor windings may be connected either in series or parallel as shown in Figure 2-8. The preferred connection mode depends on the application, since the performance characteristics differ.

Series connection gives double the ampere-turns of a single coil at a given current and there is therefore a significant increase in low-speed torque. However, the inductance per phase is increased to four times the inductance of one coil, causing the high-speed torque to drop off more rapidly.

For the same current, parallel connection results in less torque at low speeds but the torque will be maintained to higher stepping rates. The maximum power obtainable from the motor is greater in the parallel mode. With a 6-lead motor, the two halves of each winding cannot be connected in parallel. However, using one-half of each winding produces the same torque as an equivalent 8-lead motor connected in parallel. The advantage of parallel connection is a reduction in resistive losses which allows a higher current to be used.

It is most important that any unused motor leads are individually insulated, and under no circumstance should they be joined together unless this is specified in the motor connection data. *Do not attempt to use a 5-lead motor with this drive.*

Motor Cable

The recommended gauge for PKH drives is greater or equal to $1.5mm^2$. Use a cable containing four conductors plus the braided screen. The temperature rating of the cable must be greater than or equal to the motor case temperature and should be at least 80°C.

Motor Earth

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

Motor Insulation

Motor insulation must be rated to withstand at least 750V rms.

WARNING - Hot surface

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

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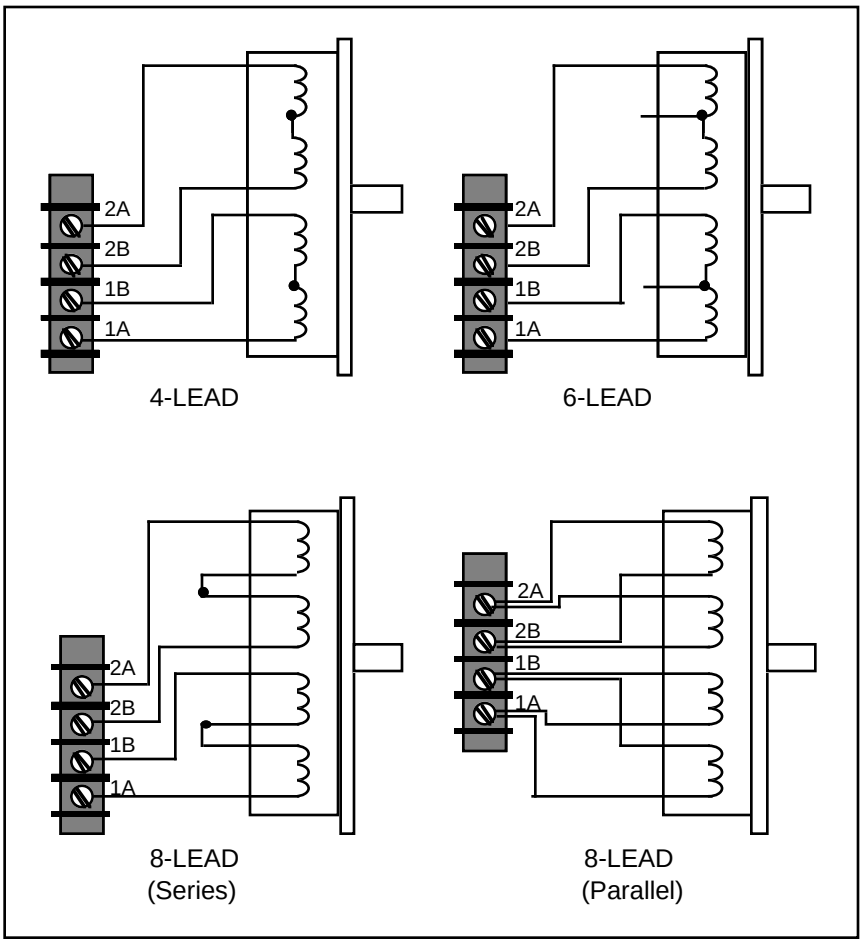


Figure 2-8. Typical Motor Connections for 4, 6, and 8 Lead Motors

IMPORTANT

When the PKH drive is powered directly from the AC supply without the recommended isolating transformer (USA only), the motor leads will be live to the AC supply. It is therefore essential that all motor connections are made either with double insulated cable or with the addition of sleeving in the case of flying lead motors. Ensure that any intermediate connections or terminations between motor and drive are also adequately insulated. Motor and cable must have an insulation rating of at least 1000Vac rms

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N.C. - no connection.

MAKE	TYPE	1A	1B	2A	2B	NOTES
Evershed & Vignoles	6-lead	Red	Green	Blue	Yellow	Brown & Black N.C.
	8-lead	Red	Green	Blue	Yellow	Link Grey & Pink, link White & Violet
	T.box	1	3	4	2	Link 5 & 6, link 7 & 8
Sigma	6-lead	Black	Orange	Red	Yellow	White/Blk/Org, White/Red/Yel N.C.
	8-lead	Black	Orange	Red	Yellow	Link Wh/Blk & Wh/Org Link Wh/Red & Wh/Yel
	T.box	1	3	2	4	Link 5 & 6,link 7 & 8
Astrosyn, Rapidsyn, Slo-syn	6-lead	Red	Red/Wh	Grn	Grn/Wh	White & Black N.C.
	T.box (x6)	1	3	4	5	2 & 6 N.C.
Slo-syn	8-lead	Red	Red/Wh	Grn	Grn/Wh	Link Black & White, link Org & Blk/Wh
	T.box (x8)	1	3	5	4	Link 2 & 6, link 7 & 8
Stebon	8-lead	Red	Yel	Pink	Blk	Link Blue & violet, link White & Grey
	T.box	1	2	3	4	Link 5 & 6, link 7 & 8
G.E.C.	T.box	1	2	3	4	Link 5 & 6, link 7 & 8
M.A.E.	6-lead	Grn/Wh	Grn	Red	Red/Wh	White & Black N.C.
	8-lead	Black	Orange	Red	Yellow	Link Wh/Blk & Wh/Org, Link Wh/Red & Wh/Yel
	T.box	6	5	8	7	Link 1 & 3, link 2 & 4
Zebotronics	T.box	1	4	5	8	Link 2 & 3, link 6 & 7
Oriental	6-lead	Black	Green	Red	Blue	Yellow & White N.C.
Sonceboz	8-lead	Green	Grn/Wh	Red	Red/Wh	Link Org & Blk/Wh, link Black & White
Japan Servo	6-lead	Red	Blue	Green	Yellow	2 x White N.C.
Escap	8-lead	Brown	Org/Wh	Red	Yel/Wh	Link Brn/Wh & Org, Link Red/Wh & Yellow.
Bodine	8-lead	Brown	Orange	Yellow	Red	Link Wh/Brn & Wh/Org, link Wh/Yel & Wh/Red.
	T.box	1	3	4	2	Link 5 & 7,link 6 & 8
Digiplan/Compumotor RM Motor	8-lead	Black	Orange	Red	Yellow	LinkWh/Blk & Wh/Org. Link Wh/Red & Wh/Yel
Digiplan/Compumotor QM Motor	8-lead	Red	Black	White	Green	Link Yel & Blue Link Org & Brown

Table 2-6. Motor Connection Data - Windings in Series

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N.C. - no connection. For 6-lead motors, connections shown are for one half-winding.

MAKE	TYPE	1A	1B	2A	2B	NOTES
Evershed & Vignoles	6-lead	Red	Brown	Blue	Black	Grn & Yellow N.C.
	8-lead	Rd & Pink	Grn & Grey	Blue & Violet	Yel & White	
	T.box	1 & 6	3 & 5	4 & 8	2 & 7	
Sigma	6-lead	Black	Wh/Blk/ Orange	Red	Wh/Red/ Yellow	Or & Yellow N.C.
	8-lead	Black & Wh/Or	Or & Wh/Blk	Red/ Wh/Yel	Yel & Wh/Red	
	T.box	1 & 5	3 & 6	2 & 7	4 & 8	
Astrosyn, Rapidsyn, Slo-syn	6-lead	Red	Black	Green	White	Red/Wh & Grn/Wh N.C.
	T.box(x6)	1	6	4	2	3 & 5 N.C.
Slo-syn	8-lead	Red & White	Blk & Red/Wh	Grn & Blk/Wh	Org & Grn/Wh	
	T.box(x8)	1 & 2	3 & 6	4 & 7	5 & 8	
Stebon	8-lead	Rd & Blue	Yel & Violet	Wh & Pink	Black & Grey	
	T.box	1 & 6	2 & 5	3 & 8	4 & 7	
G.E.C.	T.box	1 & 6	2 & 5	3 & 8	4 & 7	
M.A.E.	6-lead	Grn/Wh	White	Red	Black	Grn & Red N.C
	8-lead	Black & Wh/Or	Or & Wh/Blk	Red & Wh/Yel	Yel & Wh/Red	
	T.box	3 & 6	1 & 5	4 & 8	2 & 7	
Zebotronics	T.box	1 & 2	3 & 4	5 & 6	7 & 8	
Oriental	6-lead	Black	Yellow	Red	White	Grn & Blue N.C.
Sonceboz	8-lead	Grn & Blk/Wh	Or & Grn/Wh	Red & White	Blk & Red/Wh	
Japan Servo	6-lead	Red	White*	Green	White*	
Escap	8-lead	Brn & Orange	Brn/Wh & Org/Wh	Red & Yellow	Red/Wh & Yel/Wh	
Bodine	8-lead	Brn & Wh/Or	Wh/Brn & Orange	Yel & Wh/Red	Wh/Yel & Red	
	T.box	1 & 7	3 & 5	4 & 6	2 & 8	
Digiplan/Compumotor RM Motor	8-lead	Black & Wh/Or	Orange & Wh/Black	Red & Wh/Yellow	Yellow & Wh/Red	
Digiplan/Compumotor QM Motor	8-lead	Red & Blue	Blk & Yellow	Wh & Brn	Green & Org.	

* Use correct White for each phase.

Table 2-7. Motor Connection Data - Windings in Parallel

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I/O Connections

All input and output signals are optically isolated within the drive. Connections are made to the 8-pin terminal connector on the drive front panel (see Figure 2-5). *Pin 1 is not normally used.* Pin 8 is the common 0V return. *Do not use any other terminal as the common return for control signals.*

If you are using an indexer, refer to the indexer user guide for indexer cable colour codes.

Typical input and output circuits are shown in Figure 2-9. The input signal source must be capable of sinking approximately 15mA at the logic 0 level.

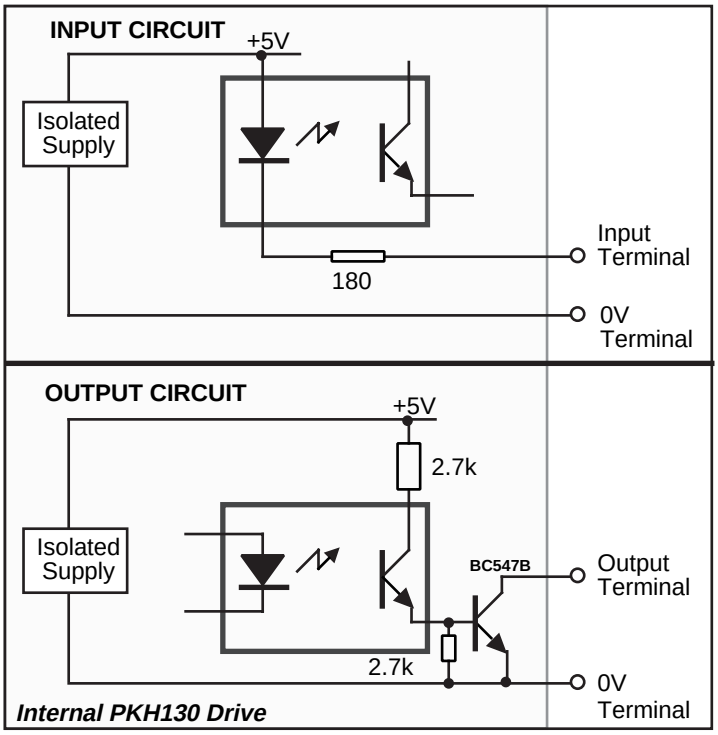


Figure 2-9. Typical Input and Output Circuits

NC/Step (Pin 1)

This input is either not connected (NC) or is a positive step input. Its use is determined by the setting of link (jumper) LK1. When LK1 is set to position 'A' input pin 1 is not connected and the input configuration shown in Figure 2-9 describes the input circuit of $\overline{\text{step}}$ input pin 6. When LK1 is set to position 'B' inputs 1 and 6 are re-configured, as shown in Figure 2-10. With this circuit arrangement you can link pin 6 to 0V and pin 1 can be used as a single ended step input or you can arrange to drive pins 1 and 6 as a differential input.

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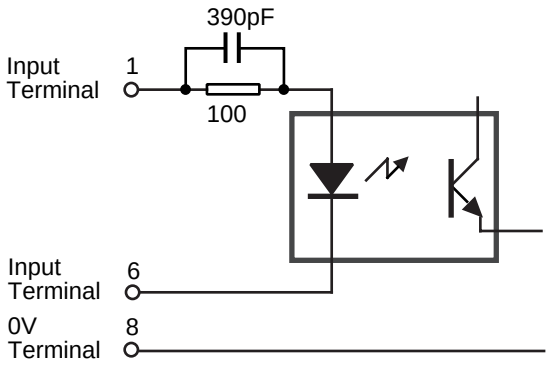


Figure 2-10. Input Circuit with Link 1 in Position B

Fault (Pin 2)

This is a composite output signal which goes high in the event of an overload, short circuit, supply failure, or over temperature fault. It is driven by an open-collector transistor and should therefore be pulled high by an external resistor when the signal is required. The resistor should be returned to a voltage not higher than ±30V and should not permit more than 15mA to flow when the output is low.

Zero Phase (Pin 3)

The zero phase output is low when the translator is in its primary state. This occurs every 8 steps in the half-step (400 step/rev) mode. The signal will therefore go low 50 times per rev, using a 200 step/rev motor. *Zero phase* corresponds to current flowing from terminal A to terminal B in each motor phase.

The *homing* feature of the indexer should be used to establish a reference position. The zero phase signal is normally used to define a precise home position.

The electrical specs are the same for the Fault output. A front-panel LED indicates when the drive is in the zero phase state.

Boost (Pin 4)

Connecting this input to 0V (pin 8) increases the motor current by approximately 30%. The drive is not rated for continuous operation with boost applied. If the input is held low, the current will revert to its normal level after 5 seconds. Boost should not be applied for more than 25% of the time, subject to a maximum time of 5 seconds. Electrically, this input is internally pulled up and has an internal current-limiting 180 Ω resistor in series with pin 4.

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Direction (Pin 5)

Taking this input low reverses the direction of motor rotation. The direction should only be changed when the motor is stationary or running within its start-stop speed range. Do not change the direction signal within 5µs of the low-going edge of a clock (step) pulse. For Compumotor indexers, connect the **Direction+** wire of the indexer cable to this input (see Appendix 1). This input is electrically identical to the Boost input.

Step (Pin 6)

The step input is electrically identical to the boost input. A low-going transition on this input causes the motor to advance one step (*low-going* = from +5V to 0V). The width of the low-going pulse should be at least 5 µs.

To ensure that the pulse is wide enough, be sure to set your indexer to the appropriate resolution. If the drive resolution is not the same as the indexer resolution, the motor may not move. *Do not set the indexer resolution higher than 2,000 steps per revolution.* Ensure that the pulse width does not exceed the maximum clock (step) frequency, which can be as high as 100 kHz operating at 2000 steps/rev or 20kHz at 400 steps/rev.

For operation with Compumotor indexers, connect the **Step+** wire of the indexer cable to this input (see Appendix 1).

Reset (Pin 7)

The reset input is also known as ***shutdown*** or ***energise*** input. When the input is taken low, the drive is de-energised and the motor shaft may be rotated slowly by hand. The action of taking the input low will also reset a fault condition, provided the cause of the fault has been removed. The drive will re-energise when the input returns to a high logic level.

This input is not directly compatible with most Compumotor indexers. If you wish to use the indexer's shutdown output, please contact Digiplan Applications - see title page for contact telephone numbers.

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CAUTION

Do not rotate the motor at high speed with the drive de-energised. This pumps power back into the drive and may overload the internal power dump circuit. Similarly, the drive should not be de-energised while the motor is running. Applications where the motor may *free wheel* (i.e., vertical travel application) may result in driver failure if the motor is de-energised and the load falls.

0V (pin 8) Use this terminal as the common return for the control signals. Do not use any other terminal for this purpose.

System Mounting

The drive may be mounted in any orientation. However, there are a number of factors to keep in mind when deciding on the location.

Airflow The temperature range for safe operation is 0°C - 40°C (32°F - 104°F). If you mount the PKH Series Drive in an enclosure with an indexer, the horizontal clearance should be no less than 150mm (6 inches). Also, do not mount large, heat-producing equipment directly beneath the PKH drive.

Signal Where there is considerable distance between the control system (indexer) and the motor, the drive should generally be located as close to the control system as possible. Long motor leads seldom present a problem as long as they have a low resistance and are shielded. Low-level control signals may become prone to noise pick-up or cross-talk problems over long distances.

Environment

The operational temperature range for the drive system is 0°C to 40°C (32°F to 104°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 PKH 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 the final application the equipment must be enclosed to prevent the operator

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coming into contact with any high voltages. This includes the transformer, drive and motor terminations.

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Chapter 3. TROUBLESHOOTING

Description

There are three basic protection systems built into the drive. These guard against damage caused by overcurrent, power supply faults, and over temperature. Operation of any of these protection circuits will de-energise (*shut down*) the drive. The reason for shutdown is indicated by an illuminated LED on the front panel. Provided the cause of the fault has been removed, the drive may be re-energised by taking control connector pin 7 (Reset) to 0V (pin 8), or by temporarily removing power. A simplified diagram of the protection circuitry is illustrated in Figure 3-1.

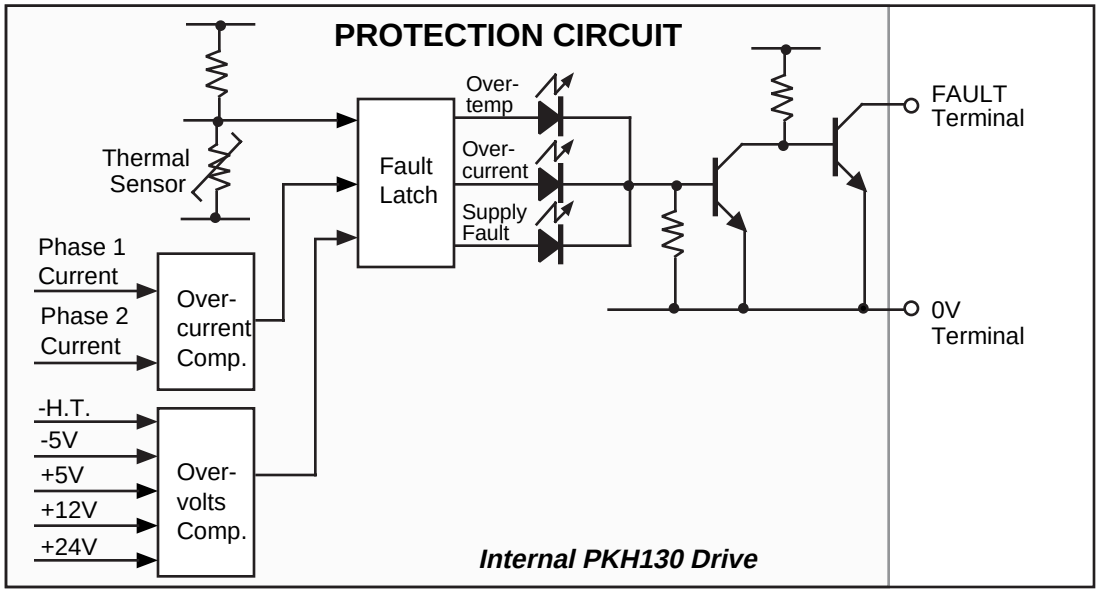


Figure 3-1. Simplified Protection Circuit

Overcurrent Protection

An overcurrent condition may be caused by incorrect motor connections, short circuits across the motor terminals, or any other condition causing excess current to flow. It may also arise if a very low inductance motor becomes desynchronised during deceleration. If any of these circumstances exist, the overcurrent comparator will set the fault latch, turning on the fault LED and giving a fault output signal.

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Supply Failure Protection

Should the high-voltage supply rise excessively, or any of the logic supply rails fall outside preset limits, the supply protection circuit comes into operation. It functions by using an operational amplifier to compare each of the supply rails with fixed reference levels. If the preset limits are exceeded, the fault latch is set and the supply failure LED is illuminated. *An excessive rise in the high-voltage supply may result from failure of the power dump fuse (FS6). This can occur if a very large inertial load is abruptly decelerated.*

Overtemperature Protection

The drive will also shut down if the heatsink temperature reaches 85°C (185°F). This is usually caused by inadequate cooling. Persistent over temperature problems indicate a faulty or obstructed fan.

The heatsink temperature is monitored by a thermal sensor attached to the heatsink. The output from the sensor sets the fault latch directly, and illuminates the over temperature LED on the front panel. Time must be allowed for the drive to cool down before it can be re-energised.

Fault-Finding Guide

If there is no response from the motor, make sure that the motor shaft is free to rotate with the drive switched off. Then turn on the power and look to see which LEDs are illuminated. If no LEDs illuminate, contact Digiplan Applications Engineering Department - contact telephone numbers are given on the title page of this guide.

Zero Phase

This LED normally illuminates on power-up, flashes at low stepping rates, and is illuminated dimly at higher speeds. From power-up the LED should be illuminated immediately, if not check both input AC supplies. If the drive has been operating, it is possible the drive will require a few commanded motor steps when an indexer is used with the drive before the LED will illuminate.

If the motor shaft is still free to rotate and there is no audible noise from the motor, check the motor connections carefully. Also check to see if the reset input (pin 7) is not held low. This will de-energise the motor.

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If the zero phase LED remains on continuously when the motor should be running (but is not), either the step pulses are not reaching the drive, or it is not responding to them. Verify that the following operating parameters are set properly:

- Step pulse width is at least 5μs
- Indexer resolution is set equal to the drive resolution
- Logic level during the pulse is not higher than +1V.

If the step pulse source does not have an open-collector output, check that the logic 1 level is between +4.7V and +7V. Most indexers come from the factory configured for high resolution drives. Refer to the indexer manual for instructions to reduce the resolution.
x

Overcurrent

Remove power from the drive, disconnect the motor, and then reapply drive power. If the overcurrent LED is still on, the drive is faulty. If not, check for short circuits or crossed connections on the motor windings. The resistance on phase 1 should be within ±10% of the resistance on phase 2.

A motor with a very low inductance could also cause this fault. Try connecting the motor in series rather than parallel. *The current rating of the motor is halved when changing from parallel to series. The Drive current setting may need to be adjusted to avoid motor damage.*

Supply Failure

Check the AC supplies to the drive terminal block. If they are correct, switch the power off and check the drive fuses. The fuses are located on the drive motherboard and are accessible by removing the six outer screws on the front panel and removing the front panel (see Figure 3-2). Fuse ratings are given in Chapter 4, Table 4-1.

Wait 2 minutes after power-off before removing the panel.

If all the fuses are sound, there is almost certainly an internal fault, and the drive should be returned for repair.

CAUTION

When replacing the front panel, be careful not to dislodge the LED cable or the chassis ground lead. Also, be careful to relocate the motherboard carefully over the edge connectors.

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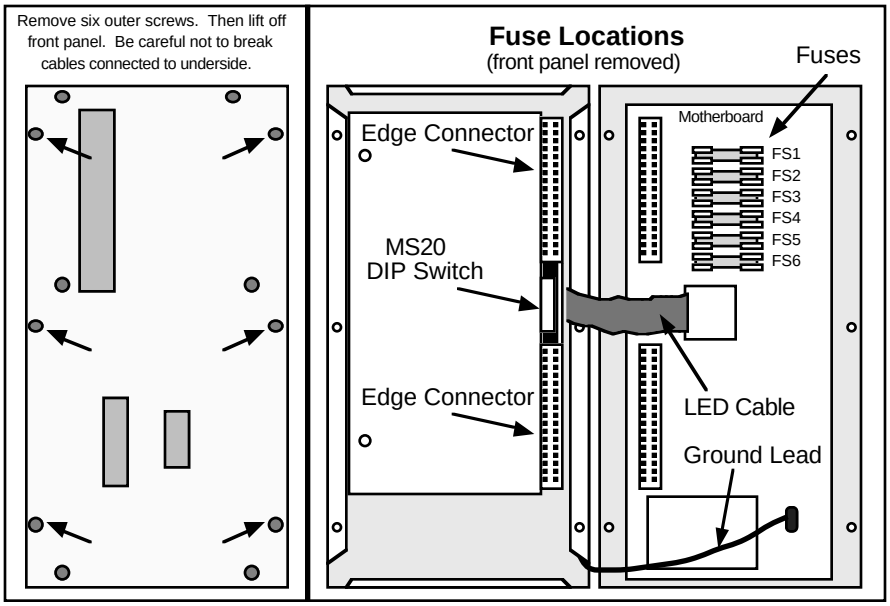


Figure 3-2. Front Panel Removal and Fuse Locations

Overtemperature This LED indicates that the drive has over-heated. Remove power from the drive and let it cool. If it was previously operating satisfactorily, make sure the ventilation slots are not obstructed and the fan is operating correctly.

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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Chapter 4. HARDWARE REFERENCE

Specifications

Parameter	Value
Amplifiers	
Type	Bipolar recirculating chopper
Motor resolution (user selectable)	PKH65/130M: 200, 400, 1,000, or 2,000 steps/rev
Protection (auto-shutdown if detected):	
Short circuit	Phase-to-phase and phase-to-ground
Brownout	If AC supply drops below 80VAC
Overtemperature	If heatsink exceeds 85°C (185°F)
Nominal output current (Two-phase-on)	PKH65M: 6.5A/phase PKH130M: 13A/phase (DIP switch selectable)
Standby current reduction	50% of motor current
Boost current	30% for a maximum of 5 seconds (internally limited)
Maximum stepping frequency	PKH65/130M: 100kHz @ 2,000 steps /rev
Command Interface	Inputs are fully optically isolated and require a TTL-type signal to operate. >3.5VDC high, <0.8VDC low. User-supplied step and direction signals must be capable of sinking up to 20mA.
Clock (Step)	Low going pulse, 5 µs min. width. Max. pulse rate is 100kHz.
Direction	Logic high = CW rotation; Logic low = CCW rotation
Reset (Shutdown)	Logic high = normal operation; Logic low = amplifier disable
Output circuits	Open-collector NPN transistor
Output logic levels	+30V max. (off), 15mA max. (on)
Input impedance	180Ω + isolator diode to +5V
Input logic level	Logic 0: ±1V or short-circuit to 0V Logic 1: +4.7V to +7V or open-circuit

Table 4-1. PKH Series Drive Specifications

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Specifications Continued

Power	
Supply voltage	100 - 480VAC with external transformer; 120VAC (±10%) without external transformer (USA only & not recommended) Supply into PKH drive is 172V max for motor, 120V for fan/logic PKH130M up to 14A PKH65M up to 7A
Frequency	50/60 Hz
Fuses (all slow-blow time delay)	
FS1, FS2, and FS3 (6.3 x 32mm)	Motor supply (L1, L2, and L3): 25A (PKH130M), 12.5A (PKH65M) high breaking capacity
FS4 (6.3 x 32mm)	Logic/fan supply: 1A high breaking capacity
FS5 (6.3 x 32mm)	Logic/fan supply: 1A high breaking capacity
FS6 (6.3 x 32mm)	Power dump: 2A
Environmental Constraints	
Drive operating conditions	0° - 40°C (32° - 104°F). Max. heatsink temp. is 85°C (185°F)
Storage	-40° - 85°C (-40° - 185°F)
Humidity	0% - 95% (non-condensing)
Motor Compatibility	
Type	2-Phase hybrid or permanent magnet (normally 1.8°)
Number of Leads	4, 6, or 8 (5 lead not suitable)
Minimum inductance	0.75 mH (PKH130M), 1.5 mH (PKH65M)

Table 4-1. PKH Series Drive Specifications (continued)

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Drive Dimensions

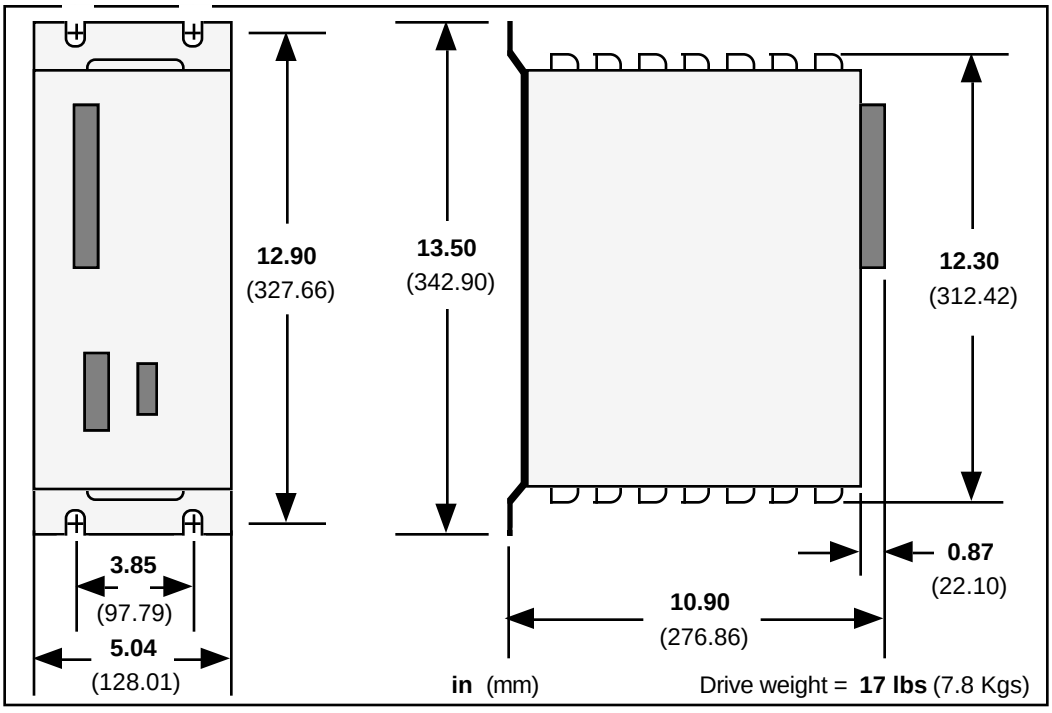


Figure 4-1. PKH Series Drive Dimensions

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Appendix

Connections for Parker Compumotor Indexers to PKH Series Drives

PKH 8 pin Connector	OEM 010 DB25	4000 DB15	PC23 DB25	3000 DB25
Clock (pin 6)	Pin 1	Pin 9	Pin 1	Pin 1
Direction (Pin 5)	Pin 2	Pin 2	Pin 2	Pin 2
Eng/Reset (Pin 7)	N/A	Pin 12	Pin 17	N/A
0 Volts (Pin 8)	Pin 7	Pin 13	Pins 14 & 15	Pins 14 & 15

Notes:

1. If motor direction is not the same as the indexer direction, interchange the motor connections between 1A and 1B.

2. The pinouts for the Model 4000 indexer also apply to the 500, 6200 and AT6400.

3. The pinouts for the PC23 apply when the Adapter Box is configured for single ended operation. See the PC23's User Manual page 155. Generally, jumpers set in even numbered locations are for differential operation, odd numbered locations for single ended.

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