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CE

SD12, SD13, SD15 & SD15M
Stepper Drives User Guide

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Part No: 1600.222.03 August, 1998

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.

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.

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.

If the equipment is used in any manner that does not conform to the instructions given in this manual , 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. SD 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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Table of Contents

INTRODUCTION 1
INSTALLATION 7
SETTING UP 37
MAINTENANCE & TROUBLESHOOTING 49
Index 53

User Guide Change Summary

This user guide, version 1600.222.03 supersedes version 1600.222.02.

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.

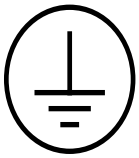
Major changes introduced at revision 03 are:

Factory settings for Ministepping SD Drive corrected.

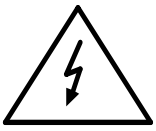
Warning symbols used on the SD series of drives have the following meanings:



Caution -
Refer to the
accompanying documentation



Protective conductor terminal



Caution -
Risk of electric shock



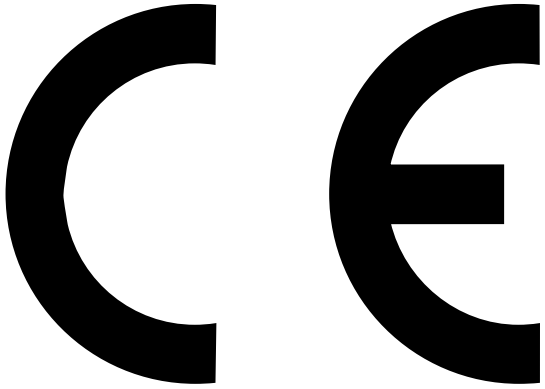
Alternating current



Caution -
Hot surface



Frame or chassis terminal



Product Type: **SD12, SD13, SD15, SD15D, SD15M, SD15MD Stepper Drives**

The above product is in compliance with the requirements of directives

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

The SD/SDM 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.

INTRODUCTION

Product Description

SD Drives are high-performance, bipolar, chopper-regulated stepper drives designed for optimum performance in low and medium power applications. They may be powered directly from DC Supplies or the secondary winding of an isolating transformer. One transformer, or one DC Supply can power several drives in a multi-axis system.

The SD-Series consists of the SD12, the SD13 and the SD15 drives (SD15WD with a power dump option). Ministepping versions include the SD15M and SD15MD (SD15M with a power dump option). Apart from motor resolution and internal oscillator speed range, ministepping drives share the same electrical specification as the SD Series drives. Where minor product variations exist a note has been included explaining the differences.

Motor rotational speed and direction are controlled by signals on the CLOCK IN and DIRECTION inputs which are accessed through the drive interface. The system may be configured to allow the clock signal to be provided by the on-board oscillator. Two separate adjustable speeds are available when the two motherboard mounted variable resistors are used. Alternatively external circuitry may be used to set the speeds. The running speed is selected remotely and the acceleration and deceleration times between the speeds, although preset at shipment, may be altered by the addition of a capacitor to the drive board. A separate selectable ENERGISE input allows disabling of the drive to allow free mechanical rotation of the motor.

SC- and SR-Series Racks

The SC/SR-series pre-wired rack assemblies can house up to six drives. Each rack system is based on a 19"(48.26cm)-long, 5.2"(13.21cm)-high rack with individual motherboards mounted on the back. The drives are mounted into the rack and plugged directly into their corresponding motherboards. This design provides a compact package, maximum flexibility, and simple solder-free screw terminal connectors. All racks fit into standard 19" rack-mount system cabinets. Table 1 identifies the racks and the number of drives each type of rack is capable of accommodating.

SR series racks are fitted with SD-type motherboards which provide a direct connection to the inputs and outputs on the drive. The control inputs (Clock, Direction and Energise) are internally pulled up to +12v and may be driven by controllers having open-collector outputs.

SC series racks are fitted with SDC-type motherboards which incorporate optical isolation of the drive signals. These racks are directly compatible with indexers such as the 500, 4000 and AT6400. A separate User Guide is supplied with the SD/IFX indexer-drive system.

Rack Model No.	SD Drives
SC/SR10	1
SC/SR20	2
SC/SR30	3
SC/SR40	4
SC/SR50	5
SC/SR60	6

Table 1. SC/SR-Series Rack Configurations

SD Drive Specifications

Parameter	Value
Amplifiers	
Type	Bipolar Chopper
Motor resolution	200 or 400 steps/rev (user-selectable)
Motor resolution (ministepping)	400, 1000, 2000 or 4000 steps/rev
Protection	
Short circuit	Phase-to-phase and across phases (not phase to ground)
Nominal output current (two-phase-on)	2A/phase (SD12), 3A/phase (SD13), 5.0A/phase (SD15) - link adjustable
Maximum stepping rate	10kHz @ 200 steps /rev 20kHz @ 400 steps /rev 200kHz @ 4000 steps/rev (ministepping only)
Nominal chopping frequency	20kHz
Command Interface	
SD drive module (alone or in an SR rack)	
Input impedance	Built-in pull-up resistors (4K7) to +12V
Input logic level	Low (logic 0) 0 to +2V or short-circuit High (logic 1) +10V to +12V or open-circuit
Output circuits	Open-collector NPN transistors
Output logic levels	Low (transistor switched to 0V) +1V max. @ 15mA max. High (transistor off) +25V max.
SD drive mounted in an SC rack	Step input is high going pulse, 10µS min. width (1.0µs min. width for ministepping) Maximum pulse rate is 20kHz (200kHz for ministepping drive) 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 providing up to 20mA.
AC Power	
Drive supply voltage	44-0-44VAC for 60VDC (supply range 18Vrms to 44Vrms ±10%)
Supply frequency range	47 to 63Hz
Logic supply voltage	18-0-18VAC (+10%, -15%) at 6VA (14VA with max DC output load)
Drive power requirements	
SD12	100VA max
SD13	150VA max
SD15/15WD/M/MD	300VA max
Aux DC output	+24V at 300mA max
DC Power	
Motor supply	22V to 60V DC (70V Abs. max)
Current requirements	
SD12	2A MAX | When operating in half step mode
SD13	3A MAX | current is reduced by 13%
SD15/15WD/M/MD	5A MAX |
Logic Supply Requirements	24V DC +10% -20%
Current Requirements	
Drive only	250mA
With auxiliary output load	550mA
Fuses	
FS1 (Logic Supply)	1A QA LB 5 x 20mm
FS2 (Motor Supply)	3.15A (SD12), 4A (SD13), 6.3A (SD15, SD15M)
Transformer primary fuses	1.5VA/supply volts - anti-surge HBC
SD15WD dump fuse	500mA TL LB 5 x 20mm

Table 2. SD Drive Specifications

SD Drive Specifications (Continued)

Internal Oscillator	
Speed range	
Fast	600 - 20,000 steps/sec (ramped)
Slow	30 - 1,000 steps/sec (not ramped)
Preset acceleration time	60 ms
Preset deceleration time	30 ms
For ministepping drive	
Speed range	
Fast	60 -3500 rpm (ramped)
Slow	3 - 135 rpm (not ramped)
Preset acceleration time	60 ms
Preset deceleration time	30 ms
Motors	
Type	2-Phase hybrid or permanent magnet (normally 1.8°)
Number of leads	4, 6, or 8 (5 lead not suitable)
Inductance range	1mH-10mH
Typical current range	SD12: 1.5—3A*
	SD13: 2—4A
	SD15: 4—6A

* For SD12, lower current can be accommodated by leaving link 4 in position "G" and changing the value of resistor R5 on the SDC motherboard or R1 on the SD motherboard.

Table 2. SD Drive Specifications (Continued)

SD15 Power Dump Option

The SD15 or SD15M Drive can be fitted with a Power Dump when used for driving high speed, high inertia loads. The option is called up as SD15WD (With Dump) or SD15MD.
You will need the SD15WD or SD15MD if the deceleration time in seconds is less than :

$$\{Jw^2 - 0.3\}$$

Where :

w is revolutions per second max.
J is the system inertia in Kg m^2

If the expression in brackets is negative, no power dump is required.

When the SD15 or SD15MD is used with a 4.2 inch motor a power dump is recommended.
The power dump has a continuous power rating of 15 Watts giving a peak dissipation of 170Watts max.

SD and SDC Auxiliary Indexer Connector Specification

Pin	Name	Type	Input/Output	Current	Voltage
1	+24V	----------	Output	250mA max	24VDC
2	Fault	OC*	Output	15mA max	12VDC
3	*Not Used*	----------	----------	----------	----------
4	*Zero Phase*	OC**	Output	15mA max	30V max
5	Direction	ACTIVE LOW** *	Input	3mA	Low <0.8VDC
6	$\overline{\text{Clock}}$		Input	3mA	High >8V or Open Circuit
7	$\overline{\text{Energise}}$		Input	3mA	(Max. 12V)
8	0V	GND	----------	----------	0VDC

* Open collector output. Not optically isolated.
** For SD motherboard only - not used on the SDC motherboard
*** Non optically isolated control input. Requires a connection to ground to activate.

Table 3. Auxiliary Indexer Connector PL1 (SDC), SKT1 (SD) I/O Specifications

SDC Indexer I/O Specification

Pin	Name	Type	I/O	Min. on State Current	Max. Current	On State Voltage	Max. Voltage	Unipolar Signal Level
1	Step +	OPTO	I	15mA	30mA	3.5V min.	5V	Low <0.8V High >3.5V
14	Step -	OPTO	I	15mA	30mA	3.5V min.	5V	0V
2	Direction +	OPTO	I	15mA	30mA	3.5V min.	5V	Low <0.8V High >3.5V
15	Direction -	OPTO	I	15mA	30mA	3.5V min.	5V	0V
16	Shutdown +	OPTO	I	7.5mA	20mA	3.5V min.	7V	Low <0.8V High >3.5V
17	Shutdown -	OPTO	I	7.5mA	20mA	3.5V min.	7V	0V
9	Fault +	OOC	O	-------	5mA	0.8V max.	12V	Open collector 12V max.
21	Fault -	OOC	O	-------	5mA	0V max.	0V	0V
6	Slow Adjust *	VAR	I	-------	20mA	-------	12V	-------
7	Fast Adjust *	VAR	I	-------	20mA	-------	12V	-------
19	Adjust Common	REF	O	-------	20mA	-------	12V	-------
12	$\overline{\text{Slow}}$	LOG	I	-------	2mA	0.8V max.	12V	Low <0.8V High Open Circuit
13	$\overline{\text{Fast}}$	LOG	I	-------	2mA	0.8V max.	12V	Low <0.8V High Open Circuit
25	0V	GND	I/O					

Table 4. SDC Indexer 25-Way Connector I/O Specifications

Notes for table 4
All other pins not used
* These pins only enabled if SDC motherboard links LK1, LK2, LK3 are set to position B
+/– Pairs with same name indicate the transmit and return connections for a particular signal

Type:
- OPTO - Opto isolated outputs for high noise immunity
- OOC - Open collector output opto isolated from drive
- VAR - Variable
- REF - DC reference
- LOG - Logical active low input
- GND - Ground connected to drive 0V

I/O Input/Output

Signal Levels - These are the voltages that should be applied to the '+' signal inputs with the '–' signal inputs held at 0V. However, for maximum noise immunity it is recommended that the signals are driven as a differential pair. The FAULT- should be connected to an external 0V and the FAULT+ used as an open collector output.

INSTALLATION

Installation Requirements

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

The SD 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 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 EMC compliance.

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.

Power Connections

The SD Series of drive can be powered from an AC or DC supply. You can make power connections directly to the drive or via an SD or SDC Motherboard.

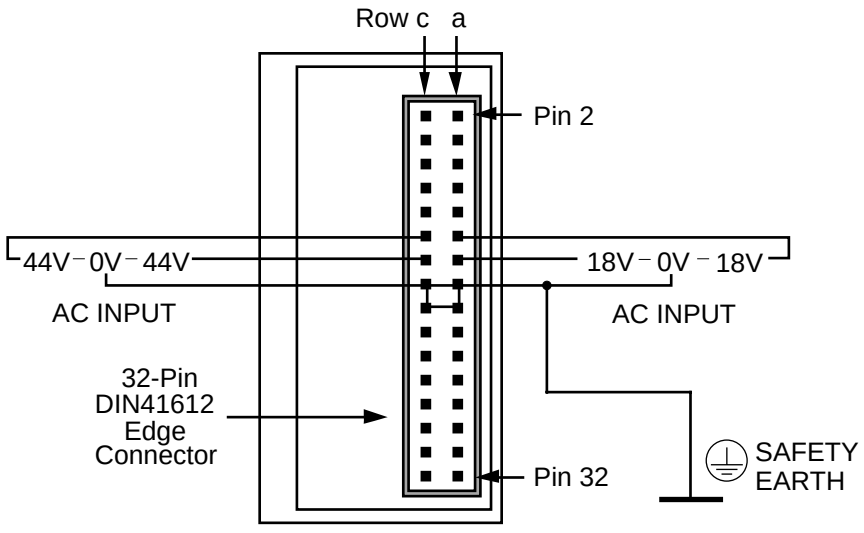


Figure 1. SD Drive Card Power Connections

The insulation ratings for power connections (AC input and motor output) should be at least 350V where the insulation is between power and signal wiring.

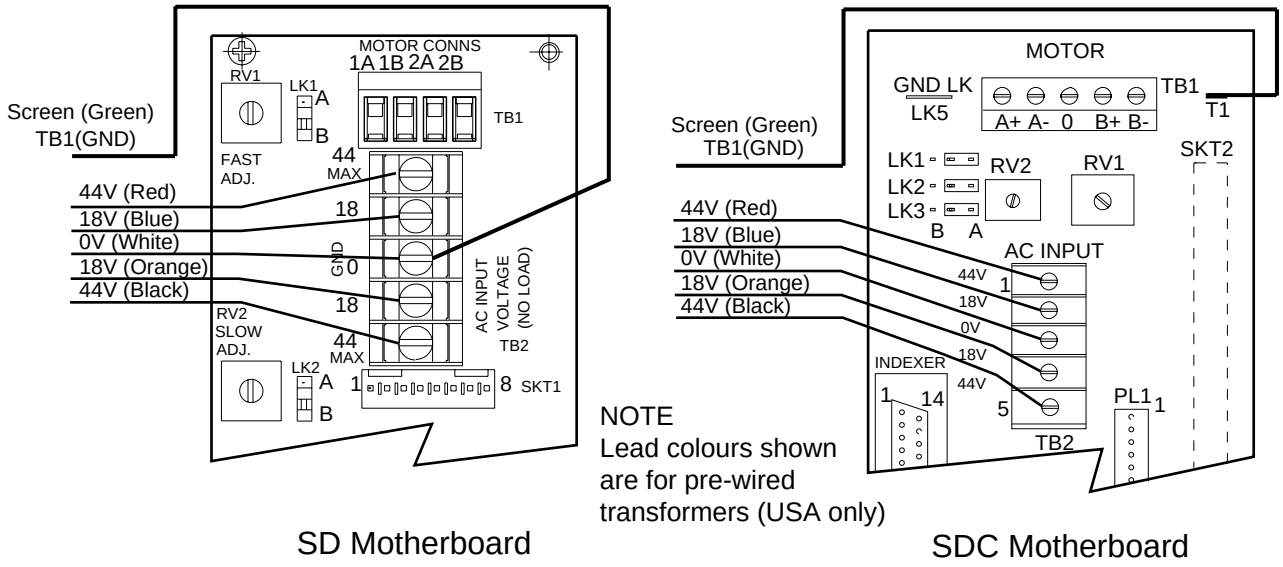
Transformer wiring needs to be at least 1mm^2 in area and the primary wiring should be routed well away from the secondary wiring and signal wiring.

Note: The drive 0V connection must be earthed.

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.

Motherboard Power Connections

The SD and SDC motherboards are wired as shown below.



SD Motherboard

SDC Motherboard

Figure 2. SD & SDC Motherboard Power Connections

DC-powered operation

SD drives may be powered from single or dual DC supplies where this is more appropriate. A single +24V supply may be used for both motor & logic supplies, although this will restrict the high-speed performance. When motor supplies greater than 24V are required, a separate 24V supply must be used for the logic supply (see Fig.3).

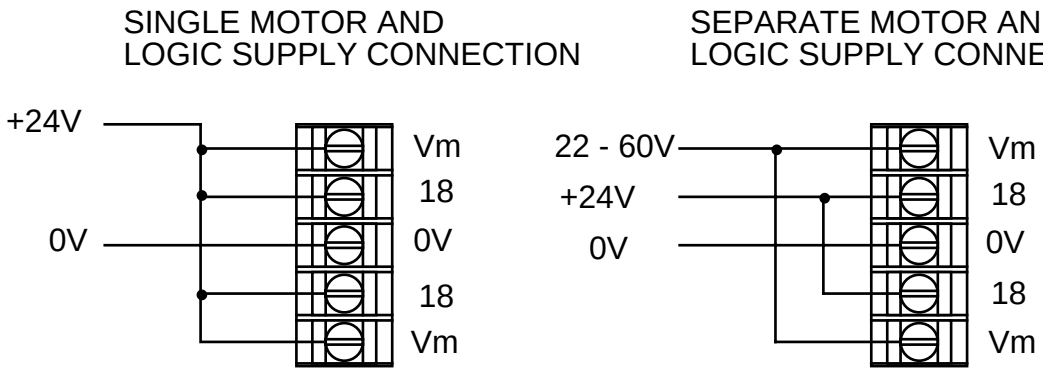


Figure 3. Alternative DC Drive Connections

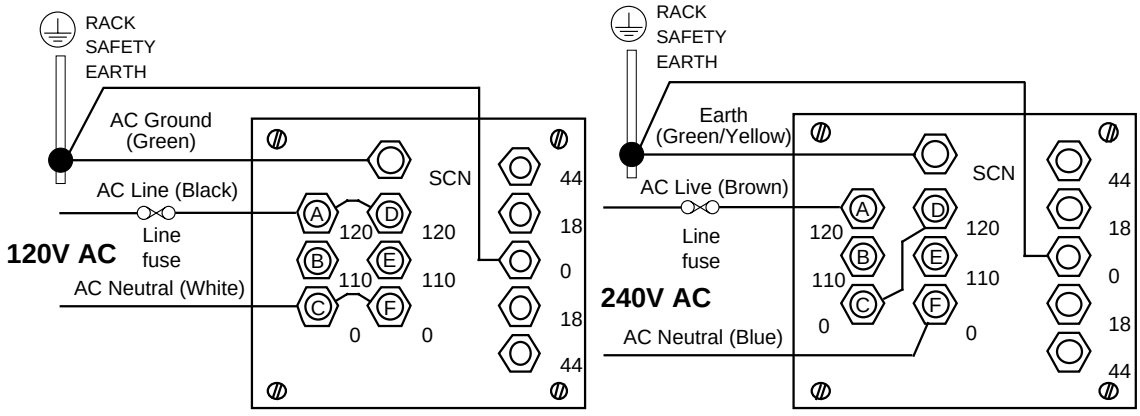
Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel and to reduce the effects of electrical noise due to electromagnetic interference (EMI).

Digiplan recommends using a central earth stud mounted on the rack end-plate or close to it. AC ground, the transformer shield, the rack 0V bus, and the enclosure metalwork should all be connected to this stud. In particular, you should connect the rack 0V bus with a 18AWG (1mm^2) cable kept as short as possible. Please note that Link 5 on an SDC motherboard connects the 0V bus to the earth tab T1.

Transformer Wiring

Depending on your application, the SD Series Drive can be powered with either the TO193 (300VA) or TO194 (600VA) transformer. If an alternative transformer is used it must have an earth screen between primary and secondary.



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

Figure 4 Primary Supply Transformer Wiring

Input Voltage	Connect AC Line to:	Connect AC Neutral to:	Connect Studs:
110	B	C	B&E; C&F
120	A	C	A&D; C&F
220	B	F	C&E
230	A	F	C&E
240	A	F	C&D

Table 5. Transformer Primary Connections

Be sure to connect the AC ground (GND) and SCN (Earth Ground) to the safety earth.

Line Fuses

Line fuses need to be added to protect the transformer and associated wiring. If the live wire cannot be readily identified. fuse both phase conductors. The value of fuse required is given by:

$$\frac{15 \times VA}{\text{supply volts}} \text{ in amps}$$

Fuse types should be anti-surge HBC. Recommended values are:

For TO193 (300VA) 3.15A TL HBC
For TO194 (600VA) 5.0A TL HBC

Motor Selection

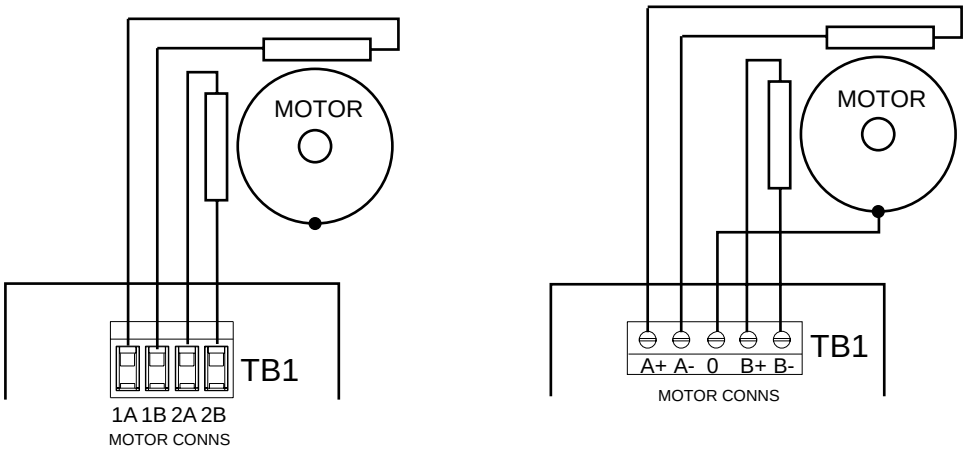
Usually optimum performance will be obtained when the current rating of the motor is between 1 and 1.5 times the drive rating (refer to specification).
For maximum high speed torque a motor rating of 7.5A should be used with the SD15, 4.5A with the SD13 and 3.0A with the SD12. The drives can be derated to accommodate motors with lower current ratings however, the high speed torque will be reduced.
Do not use a drive setting which gives an output current greater than the motor rating.
With 4 lead motors the bipolar rating is quoted and this should match the criteria stated above.
With 6 lead motors the unipolar rating is quoted, but for best performance with the SD Series the centre tap of each winding should be left unconnected and the connections made between the winding ends. This will give a bipolar rating 70% of the quoted motor unipolar rating. So a motor unipolar rating of 3.0A should be used with the SD12.
With 8 lead motors the bipolar rating of the motor, which is normally quoted, refers to a parallel winding connection. With the windings connected in series the current rating of the motor connection will be 50% that of the bipolar rating, and the motor will give improved low-speed torque, but reduced high-speed torque.

Long Motor Leads

Using a motor with long leads will cause the cabling resistance to become significant when compared to the resistance of the motor. The DC volt drop of the cable and motor connection, when measured at the drive, should not exceed 5 volts in order to limit power dissipation in the drive and maintain maximum system performance. See **Motor Cables** in the **EMC Installation** sub-section.

Motor Connections

If you purchased a Digiplan stepper motor with the drive system the following information describes typical connection details.



SD Motherboard SDC Motherboard

Figure 5 Motherboard Motor Connections

Motor Insulation

Motor insulation must be capable of withstanding voltages of at least 500V.

Motor Cable

The recommended gauge for SD drives is $1mm^2$. Use a cable containing five conductors plus the braided screen, the fifth (green) wire being used to provide a safety earth return to the drive. The temperature rating of the cable should be at least 80°C.

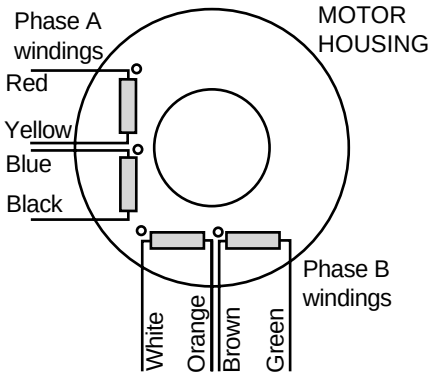
Motor Earth

The motor body must be reliably earthed. Also see **Motor Connections** in the **EMC Installation** sub-section.

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

Drive Connections to 'S' or 'QM' Motors

'S' series and 'QM' series motors are electrically identical. In the case of 23 and 34 (57 and 83) frame sizes, the motors are constructed with an 8 core cable to allow you to select either a series or parallel wiring configuration.



8-Lead Motor Winding Colour Code for S or QM Motors

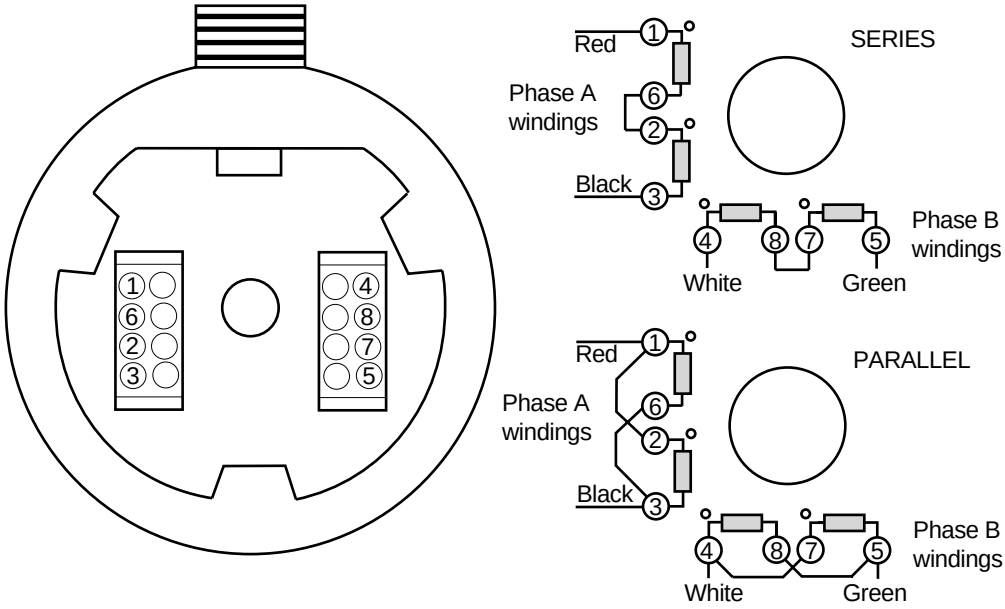
The 42 (106) frame size motors are constructed with a 4 core motor cable to connect to the drive - these motors can be configured by removing the rear cover plate and rewiring at the screw terminals. The following diagrams illustrate the connection methods for these motors.

QM106-178/ S106-178 Series and Parallel Connections

This motor is pre-wired in series. If you remove the motor's back panel, access is provided to re-wire the motor in parallel.

The motor wiring colour code is:

Motor Terminal	Wire Colour	SDC Terminal	SD Terminal
1	Red	A+	1 A
3	Black	A-	1 B
5	Green	B+	2 B
4	White	B-	2 A
Body	Bare (Screen)	Gnd	



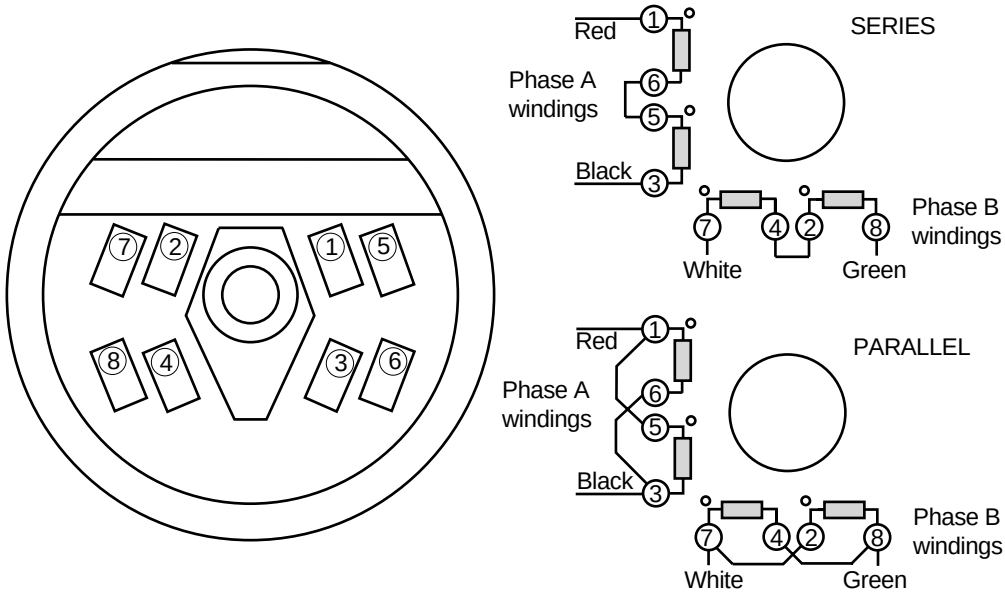
QM106-178/S106-178 Series and Parallel Connections

QM106-205/ S106-205 Series and Parallel Connections

This motor is pre-wired in series. If you remove the motor's back panel, access is provided to re-wire the motor in parallel.

The motor wiring colour code is:

Motor Terminal	Wire Colour	SDC Terminal	SD Terminal
1	Red	A+	1 A
3	Black	A-	1 B
5	Green	B+	2 B
4	White	B-	2 A
Body	Bare (Screen)	Gnd	



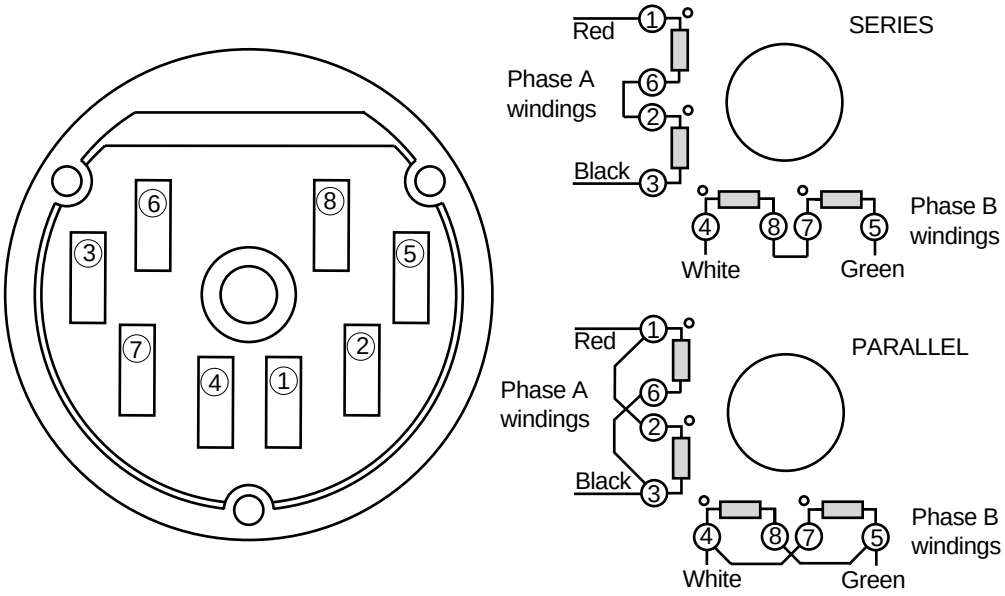
QM106-205/S106-205 Series and Parallel Connections

QM106-250/ S106-250 Series and Parallel Connections

This motor is pre-wired in series. If you remove the motor's back panel, access is provided to re-wire the motor in parallel.

The motor wiring colour code is:

Motor Terminal	Wire Colour	SDC Terminal	SD Terminal
1	Red	A+	1 A
3	Black	A-	1 B
5	Green	B+	2 B
4	White	B-	2 A
Body	Bare (Screen)	Gnd	



QM106-250/S106-250 Series and Parallel Connections

N.C. - no connection.

MAKE	TYPE	1A A+	1B A–	2A B-	2B B+	(SD) (SDC)	NOTES
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,	6-lead	Red	Red/Wh	Grn	Grn/Wh		White & Black N.C.
Slo-syn	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, Digiplan SM	8-lead	Red	Yel	Pink	Blk		Link Blue & violet, link White & Grey
	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 OEM Series	4-lead 8-lead	- Red	- Black	- Green	- White		Internally wired in parallel Link blue & yellow Link orange & brown
Digiplan/Compumotor QM Motor	8-lead	Red	Black	White	Green		Link Yel & Blue Link Org & Brown
Digiplan/Compumotor S Motor	8-lead	Red	Black	White	Green		Link Yel & Blue Link Org & Brown

Table 6. Motor Connection Data - Windings in Series

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

MAKE	TYPE	1A A+	1B A–	2A B-	2B (SD) B+ (SDC)	NOTES
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, Digiplan SM	8-lead	Rd & Blue	Yel & Violet	Wh & Pink	Black & Grey	
	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 OEM Series	4-lead 8-lead	Red Red & Blue	Black Yellow & Black	Green Green & Orange	White Brown & White	
Digiplan/Compumotor QM Motor	8-lead	Red & Blue	Blk & Yellow	Wh & Brn	Green & Org.	
Digiplan/Compumotor S Motor	8-lead	Red & Blue	Blk & Yellow	Wh & Brn	Green & Org.	

* Use correct White for each phase.

Table 7. Motor Connection Data - Windings in Parallel

SD Drive Connections

You will need to make connections directly to the drive edge connector if you are not using either of the standard motherboards. The edge connector pin functions are detailed below.

Pinouts		
Pin	Row a	Row c
2	Motor Phase B-	Motor Phase B-
4	Motor Phase B+	Motor Phase B+
6	Motor Phase A-	Motor Phase A-
8	Motor Phase A+	Motor Phase A+
10	+24VDC	+24VDC
12	Logic Supply 1	Motor Supply 1
14	Logic Supply 2	Motor Supply 2
16	0V	0V
18	0V	0V
20	Fast	Fault
22	Slow	Zero Phase
24	Rate Adjust Com.	Slow Rate Adjust
26	Fast Rate Adj.	Direction
28	Internal Clock Out*	Clock In
30	*Not Connected*	Energise
32	External Ref.*	Signal 0V‡

*Not connected on ministepping drives

‡Reserved on ministepping drives

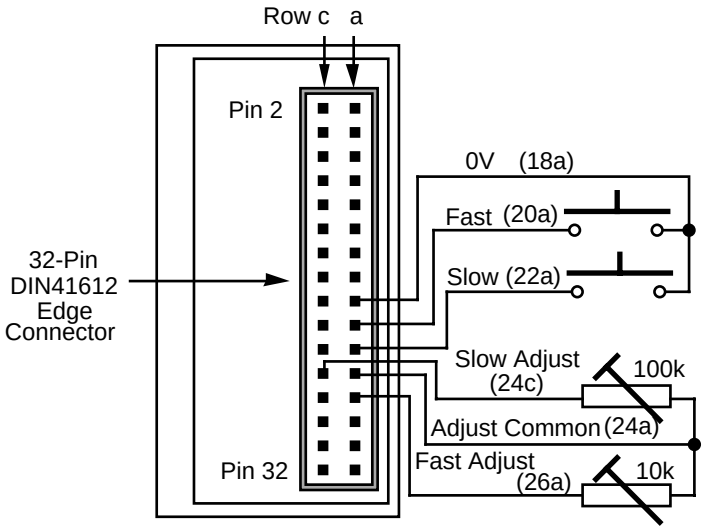


Figure 6 Direct Drive Connections

Drive Signal Descriptions

The signals at the 32 way drive edge connector are as follows:

Motor Phases

Connect one phase of the motor to A+ and A-, and the other phase to B+ and B- (connect corresponding pins in row a and row c in parallel).

+24VDC

This output is used to supply up to 300mA to an external control module such as an indexer card.

Logic Supply Inputs 1 & 2

When the drive is AC powered, these two inputs (pins 12a and 14a) are connected to the centre-tapped secondary on an isolation transformer rated at 18-0-18 volts rms. The centre tap is connected to 0V (pins 16 and 18).

Motor Supply Inputs 1 & 2

For operation at a motor supply of 60V DC, these inputs (pins 12c and 14c) may be driven from the same isolated transformer secondary as the logic supply inputs. Operation with a motor supply of 60V will require a secondary winding tapped 44-18-0-18-44. Pins 12c and 14c are connected to the 44V rms tappings and pins 12a and 14a are connected to the 18V rms tappings.

Fast Input

Connect to 0V to run the internal oscillator at the fast rate.

Fault Output

This is an open collector output which goes high (open-circuit) if the drive fault circuit operates as a result of an overload or short-circuit. The fault circuit may be reset by temporarily removing power or by taking the Energise input high.

Slow Input

Connect to 0V to run the internal oscillator at the slow rate.

Zero Phase Output

This is an open collector output which is low during the "zero phase" state of the translator, this being the primary state in which the translator is set when power is applied. Otherwise this output goes high (open circuit).

Fast Rate Adjust

An external potentiometer may be connected between this terminal and "Rate Common" (terminal 14) to control the fast speed of the internal oscillator. A suitable value for the external resistor is 10K.

Slow Rate Adjust

This is used in the same way as terminal 12 but for the slow speed, and a suitable resistor value is 100K.

Direction Input

Connect to 0V to reverse the direction of motor rotation. This input should not be changed when the step input is low, or whilst the motor is running above its start/stop speed (see timing diagram for details of when this input can be changed).

For the ministepping drive the direction input will need to be stable for at least 2.5µs before the clock.

Internal Clock Output

This is the output of the internal oscillator, and it can be connected to the CLOCK input (pin 28c). The output (pin 28a) consists of low-going pulses approximately 25µS wide. This output is not available on ministepping drives.

Clock Input (Step Input)

The motor will step following a low-going transition on this input, the step occurring on the leading edge of the pulse. The input should remain low for at least 10µS. It may be driven from an external oscillator card, a processor interface unit or the internal oscillator in the drive. See Timing Diagram.

The ministepping clock input should remain low for not less than 1µs. The maximum step pulse frequency is 200kHz in the 4000-step mode.

Energise Input

The motor will be energised with this input connected to 0V. When the input is released, the power switches are turned off and the motor shaft is free to rotate. Drive Link 3 may be fitted in position "E" as an alternative to making an external connection to 0V. Note that the drive should not be de-energised when the motor is running at speed.

External Reference Input

As an alternative to using the drive links, you can program the motor current by connecting an external resistor between this input (pin 32a) and signal 0V (pin 32c). This input is not available on ministepping drives.

Signal 0V

Use this terminal as the return connection for a current programming resistor. ***Do not confuse this pin with the power 0V pins, 16a/c 18a/c; it should not be used as a power or control signal 0V.*** This terminal is reserved on ministepping drives.

Timing Diagrams

The following timing diagrams define the clock pulse shape and the restrictions placed upon the timing of direction changes for full and half stepping non-ministepping drives.

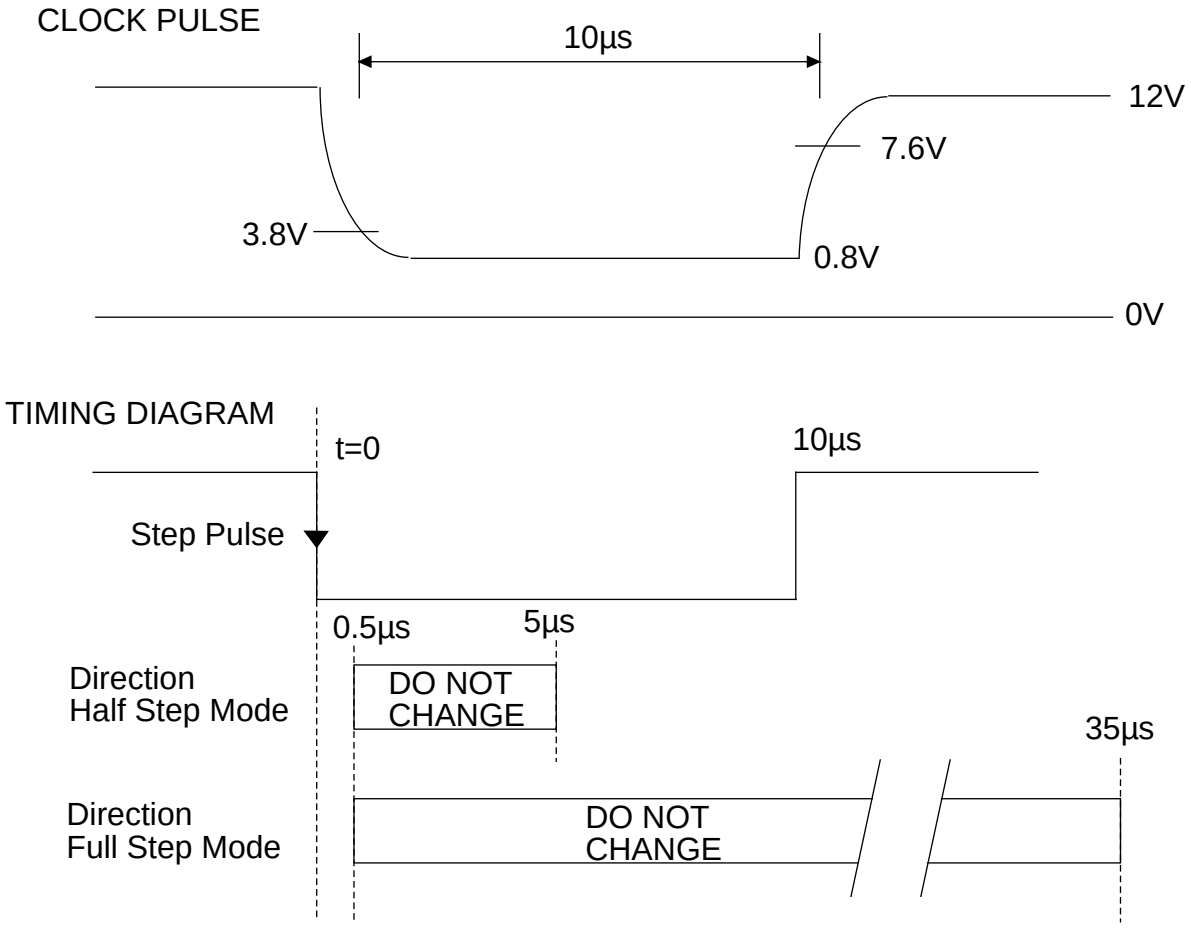


Figure 7 Step Pulse Timing Diagram

Figure 8 shows the clock pulse timing required at the drive inputs for a ministepping drive. The signals will be inverted by motherboard optocouplers.

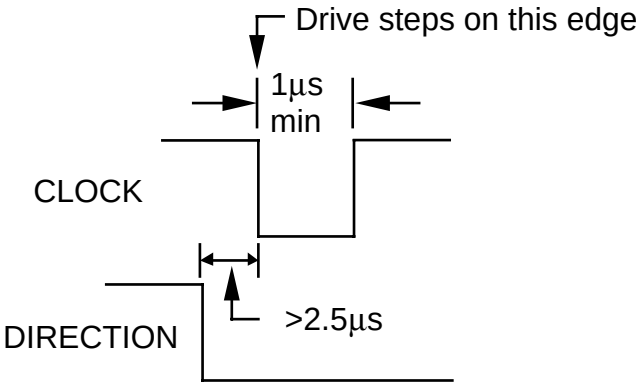
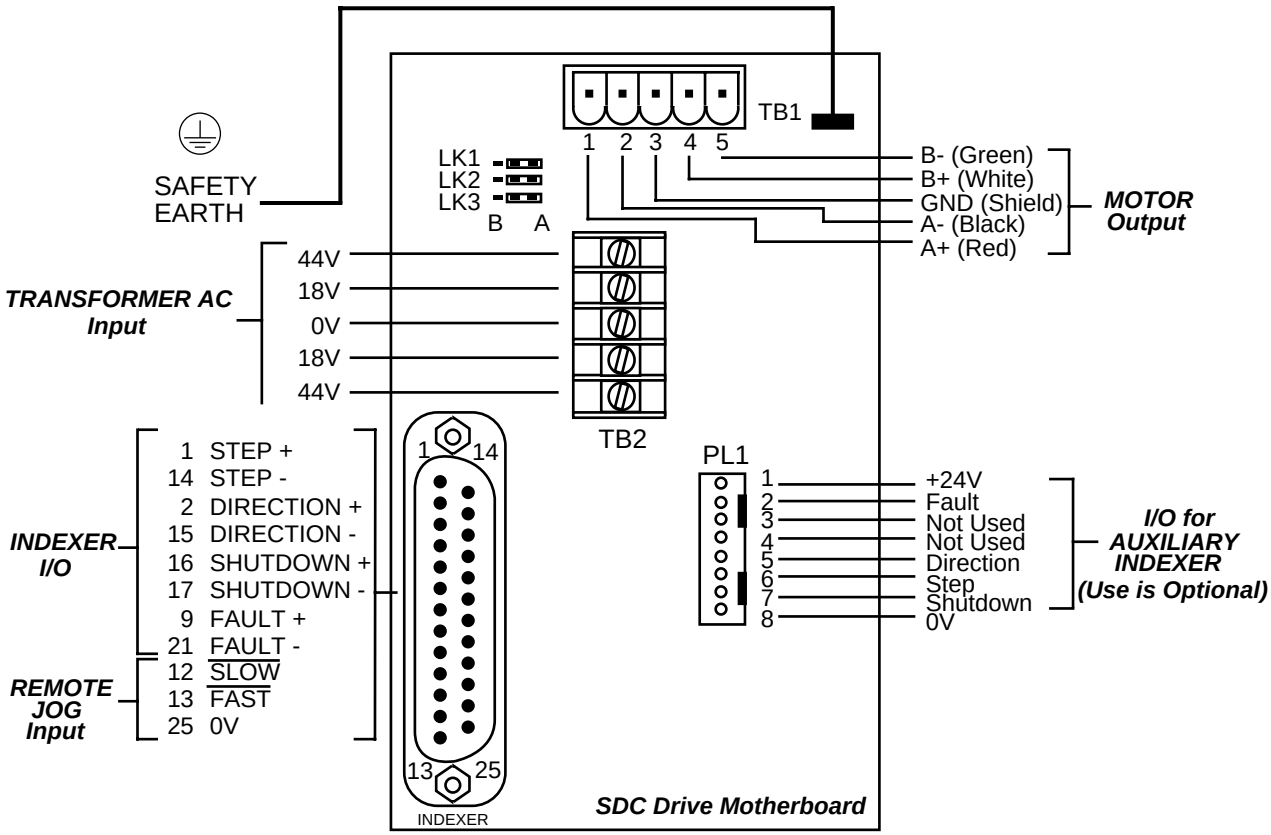


Figure 8 Clock Pulse Timing Diagram for Ministepping Drive

SDC Motherboard Connections

This section describes the pinouts and connectors of the SDC Motherboard. The I/O specifications for the INDEXER and AUXILIARY INDEXER connectors is given in the ***Specification*** part of this User Guide. See **EMC Installation** for earthing and screening EMC requirements.



NOTE: If motherboard jumpers LK1, LK2 & LK3 are set to position B, then pin 6 = Slow Adjust, pin 7 = Fast Adjust, and pin 19 = Adjust Common become available on the 25 way D-connector

Figure 9 SDC Motherboard Inputs and Outputs

Signal Descriptions - SDC Motherboard

Indexer inputs (compatible with most Digiplan and Compumotor indexers) are transmitted via the Indexer connector on the SDC Motherboard. These inputs are optically isolated on the motherboard and are intended to be driven differentially from 5V logic levels. Figure 10 represents the input circuits.

Note: signal are inverted by the opto-couplers.

Step+ & Step-

A pulse on these inputs (i.e. pin 1 positive with respect to pin 14) causes the motor to step on a low-to-high transition. The pulse should remain high for at least 10µS (1µs for the ministepping drives). Consult your indexer user guide for instructions on how to change the output pulse width.

Direction+ & Direction-

These inputs (pins 2 and 15) control the direction of the motor shaft rotation. Changing the level of these inputs changes the direction in which the shaft moves (see timing diagram).

Shutdown+ & Shutdown-

These differential inputs (pins 16 and 17) are used to energise and de-energise (*shutdown*) the motor. To remotely shutdown the drive, you must first ensure LK3 on the drive board is in the remote energise position (F position). When the shutdown+ input is taken high and shutdown- is low, the drive is shut down and the motor shaft may be rotated ***slowly*** by hand. *NOTE: Back-driving the motor may stress the drive and could cause failure.* Taking the shutdown+ input high whilst shutdown- is low resets a fault condition, and the drive is re-energised when the input returns low.

Remote Advance Rate Inputs

If you set links LK1, LK2, and LK3 on the SDC Drive motherboard to position B, the **Adjust Common**, **Fast Adjust**, and **Slow Adjust** signals are diverted to the 25-pin indexer connector (see note with Figure 8 for pinouts). Using these pins, you can wire remote jog potentiometers (pots) as demonstrated in ***Setting Up***.

Auxiliary Indexer I/O

PL1 on the back of the SDC Motherboard is an 8-pin ramp connector providing connections for the four drive control signals - see Auxiliary Indexer Connections.

Interfacing Circuits

Figure 10 shows methods of connecting signals to the SDC Motherboard via SKT 1. The equivalent devices in alternative logic families to those quoted are not necessarily compatible. Methods other than those shown may be used but they should comply with the requirements shown in Table 4.

Optically Isolated Inputs

These circuits are designed for maximum noise immunity and especially where long leads are necessary and interference fields exist, the ideal input arrangement is a differential line driver with twisted pair cabling to the inputs. Cable length should always be kept as short as possible.

Input Circuit B could be used as an alternative to the line driver circuit but poorer noise immunity would result.

Input Circuit C would operate satisfactorily where the cable length is short and interference fields are minimal.

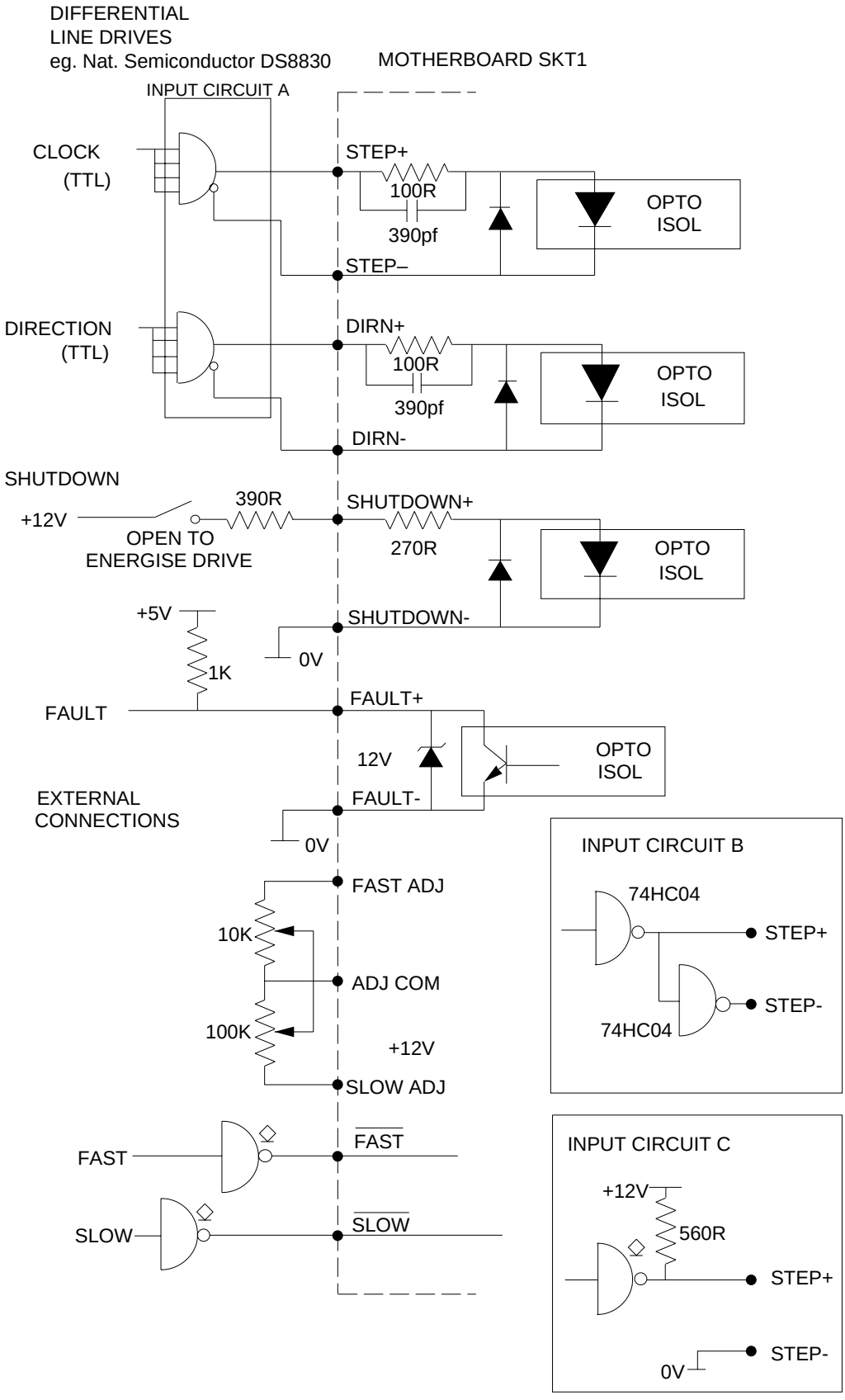


Figure 10. SDC Motherboard SKT 1 Interfacing Circuits

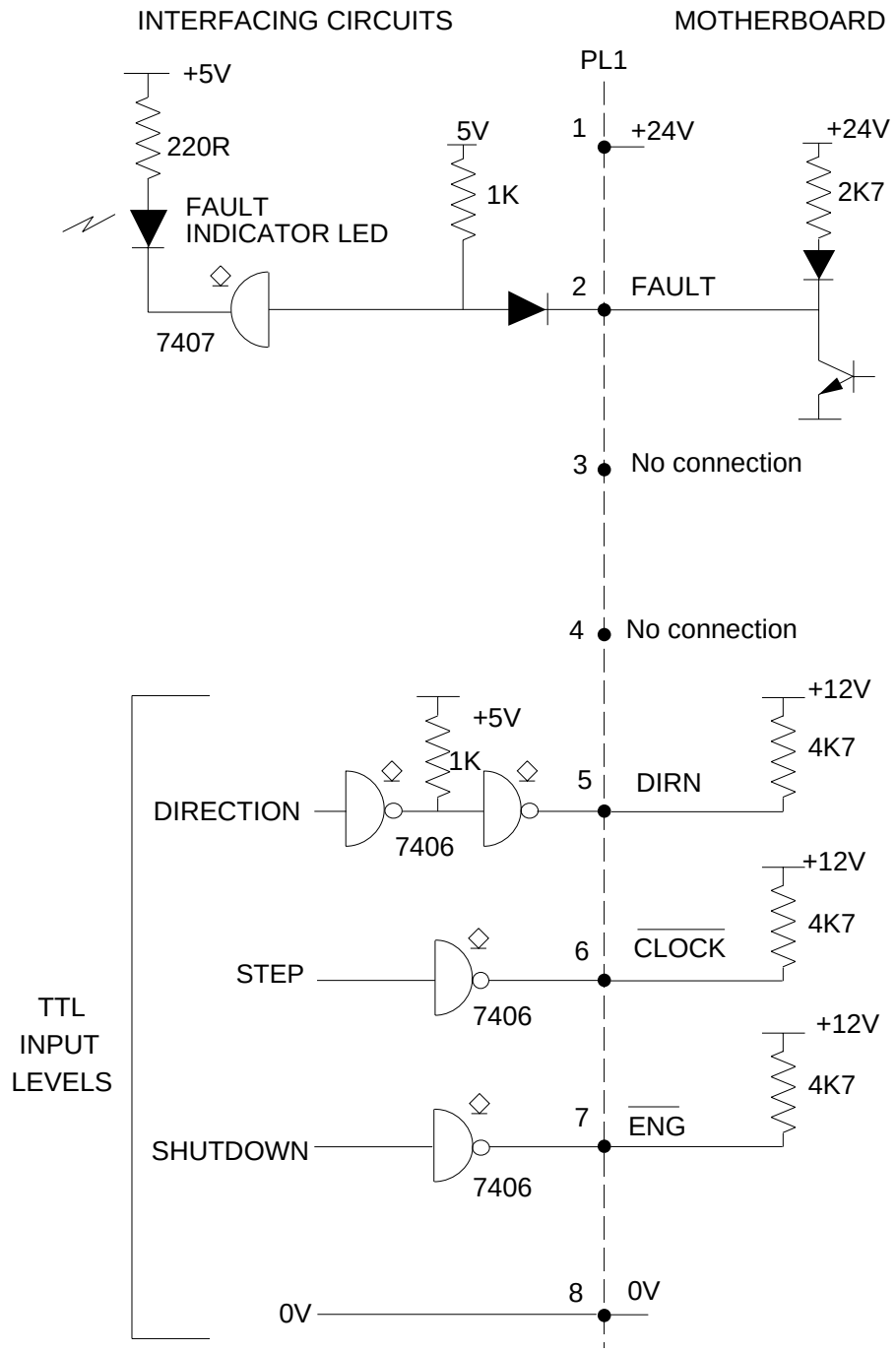
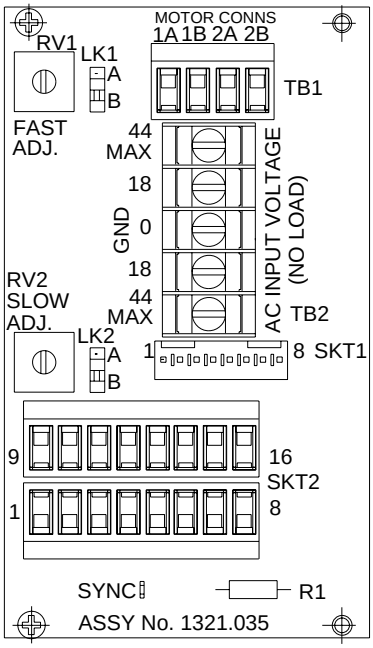


Figure 11. Interfacing to SDC Motherboard PL1

SD Motherboard Connections

The use of an SD Motherboard simplifies the installation of the drive since all external connections may be made without the need for soldering. Opto-isolation of the main control signals is NOT provided with this motherboard, but it incorporates preset controls for setting the speed of the internal oscillator without the need for external components. Links 1 and 2 on the motherboard are are fitted in position "B" to use the preset controls. When external speed controls are required for the on-board oscillator, fit the links in position "A".



SKT2

PIN	FUNCTION
1	External Ref. Input
2	+24V DC Out
3	Fault Output
4	Zero Phase Output
5	Direction Input
6	Energise Input
7	Clock Input
8	0V
9	Signal 0V
10	Fast Input
11	Slow Input
12	Fast Rate Adjust
13	Slow Rate Adjust
14	Rate Common
15	Internal Clock Output
16	0V

Figure 12. SD Motherboard Component Layout

Signal Descriptions - SD Motherboard

The control signals which appear on two 8-way terminal connectors (SKT2) on the SD Motherboard are:

1. External Reference Input (VREF EXT)

The motor current may be programmed by means of an external resistor connected between this input and Signal 0V (terminal 9). Alternatively the resistor may be fitted in position R1 on the motherboard. Suitable resistor values are given in the section on ***Setting Up*** (Table 12). Ministepping drives cannot be programmed using external resistors.

2. +24VDC Out

This output is used to supply up to 300mA to an external control module such as an indexer card.

3. Fault Output

This is an open collector output which goes high (open-circuit) if the drive fault circuit operates as a result of an overload or short-circuit. Once the cause has been corrected, the fault circuit may be reset by temporarily removing power or by taking the Energise input high.

4. Zero Phase Output	This is an open collector output which is low during the "zero phase" state of the translator, this being the primary state in which the translator is set when power is applied. Otherwise this output goes high (open circuit).
**** 5. Direction Input***	Connect to 0V to reverse the direction of motor rotation. This input should not be changed when the step input is low, or whilst the motor is running above its start/stop speed.
**** 6. Energise Input***	The motor will be energised with this input connected to 0V. When the input is released, the power switches are turned off and the motor shaft is free to rotate. Drive Link 3 may be fitted in position "E" as an alternative to making an external connection to 0V. Note that the drive should not be de-energised when the motor is running at speed.
**** 7. Clock Input (Step Input)***	The motor will step following a low-going transition on this input, the step occurring on the leading edge of the pulse. The input should remain low for at least 10µS. It may be driven from an external oscillator card, a processor interface unit or the internal oscillator in the drive. For the ministepping drives the motor will also step following a low-going transition on this input, the step occurring on the leading edge of the pulse. The input should remain low for at least 1.0µS.
8. & 16. 0V	Use this terminal as a return for control signals and the +24V supply.
9. Signal 0V	Use this terminal as the return connection for a current programming resistor (see terminal 1). ***Do not confuse this pin with the power 0V pins, it should not be used as a power or control signal 0V.***
**** 10. Fast Input***	Connect to 0V to run the internal oscillator at the fast rate.
**** 11. Slow Input***	Connect to 0V to run the internal oscillator at the slow rate.
12. Fast Rate Adjust	An external potentiometer may be connected between this terminal and "Rate Common" (terminal 14) to control the fast speed of the internal oscillator. Alternatively the fast rate may be set by RV1 on the motherboard. To use an external control, transfer Link 1 on the motherboard from "B" to "A". A suitable value for the external resistor is 10K.
13. Slow Rate Adjust	This is used in the same way as terminal 12 but for the slow speed, and a suitable resistor value is 100K. Transfer Link 2 on the motherboard from "B" to "A" when using an external control in place of RV2 on the motherboard.
14. Rate Common	Common return connection for external speed controls.

15. Internal Clock Output

This is the output of the internal oscillator which will normally be connected to the clock input of the drive (terminal 7). The output consists of low-going pulses approximately 25µS wide.

***** These signal inputs should be pulled low (i.e. to a voltage less than 0.8V) with circuitry capable of sinking 5mA. At other times the input should be open circuit or pulled to a voltage greater than +8V. The input has an internal pull-up resistor to +12V.

Auxiliary Indexer Connections

The PL1 (SDC Motherboard) and SKT1 (SD Motherboard) connectors provide optional connections for non-TTL Digiplan indexers, clock cards (MC1, BC7, RC9, etc.), or an indexer that has output characteristics that differ from TTL indexers (see Figure 12).

If you are not using a Digiplan indexer with standard Digiplan cables, it may be easier for you to use connector PL1. The electrical specifications for this connector are provided in Table 3. The inputs on PL1/SKT1 are not compatible with Digiplan or Compumotor TTL indexers.

***NOTE**: Caution must be used since these inputs are not optically isolated.*

Link cables are available from Digiplan (250mm cable: p/n CABLE250, or 450mm cable: p/n CABLE450). Refer to Figure 13 for the PL1 auxiliary indexer connector location and pinouts.

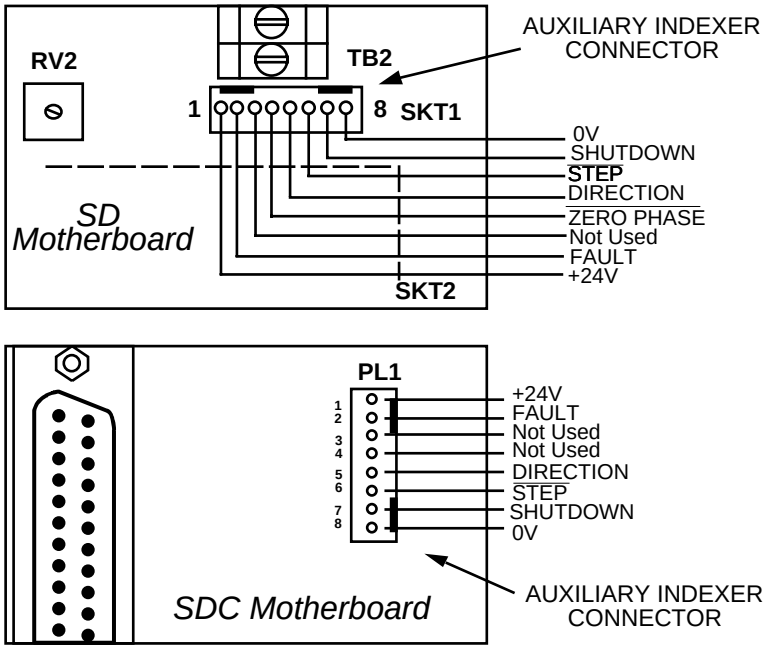


Figure 13. Motherboard Auxiliary Indexer Connectors

Auxiliary Indexer Pin Functions

Both motherboards offer auxiliary indexer pin functions similar to those offered by the SD Drive. Table 8 provides a cross reference of SD and SDC Motherboard auxiliary indexer pin functions. Note Zero Phase (SD SKT1.4) is not available on the SDC Motherboard.

SDC PL1	SD SKT1	SD Equivalent Signal Description	Comments
1	1	+24V	
2	2	FAULT output	See Fig 13
3	3	-	Not used
4	4	Zero Phase output	SD only - see below
5	5	DIRECTION input	Not TTL compatible
6	6	CLOCK input	Not TTL compatible
7	7	ENERGISE input	Not TTL compatible
8	8	0V Signal return	

Table 8. Auxiliary Indexer Pin Functions

Fault (Pin 2)

This is an output signal which goes high in the event of an overload fault. It is driven by an open-collector transistor and should be pulled up by an external resistor when the signal is required. The resistor should be returned to a voltage no higher than +25V, and should not allow more than 15mA to flow when the output is low.

When a fault occurs, the drive will de-energise. Once the fault has been cleared the drive may be re-energised by either cycling the Shutdown/De-energise signal or by cycling the power to the drive.

You can establish a visual fault verification by installing an LED as illustrated in Figure 14. Here the LED will be lit unless there is a fault.

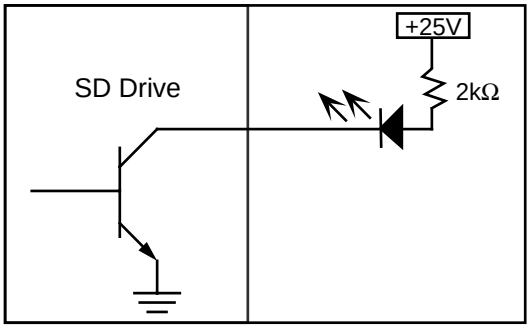


Figure 14. Fault Output Example

Zero Phase (Pin 4)

This is an output signal that goes low when the drive translator is in its primary state. This occurs every 8 motor steps in the half-step mode. The drive always powers up in the zero-phase state. This signal is used in conjunction with an auto-homing circuit. Electrical parameters are the same as those of the Fault output.

Optional Advance Rate Pot and Switch Connections

If you set links LK1, LK2, and LK3 on the SDC Drive motherboard to position B, the **ADJUST COMMON**, **FAST ADJUST**, and **SLOW ADJUST** signals are diverted to the 25-pin indexer connector. Using the connections shown in Figure 15 remote jog potentiometers (pots) and remote slow/fast jog switches can be fitted to select speed ranges of 40 to 1,000 steps/sec, or 400 to 10,000 steps/sec. Note by using the PL1 connector pin 5 you can also remotely control direction.

NOTE: The jog switches should be used only if the indexer does not need to track the motor's position.

Figure 15 also shows the corresponding external connections on the SD motherboard. Note that links LK1 and LK2 should be transferred to position 'A' to isolate the board-mounted rate adjust controls when external pots are used.

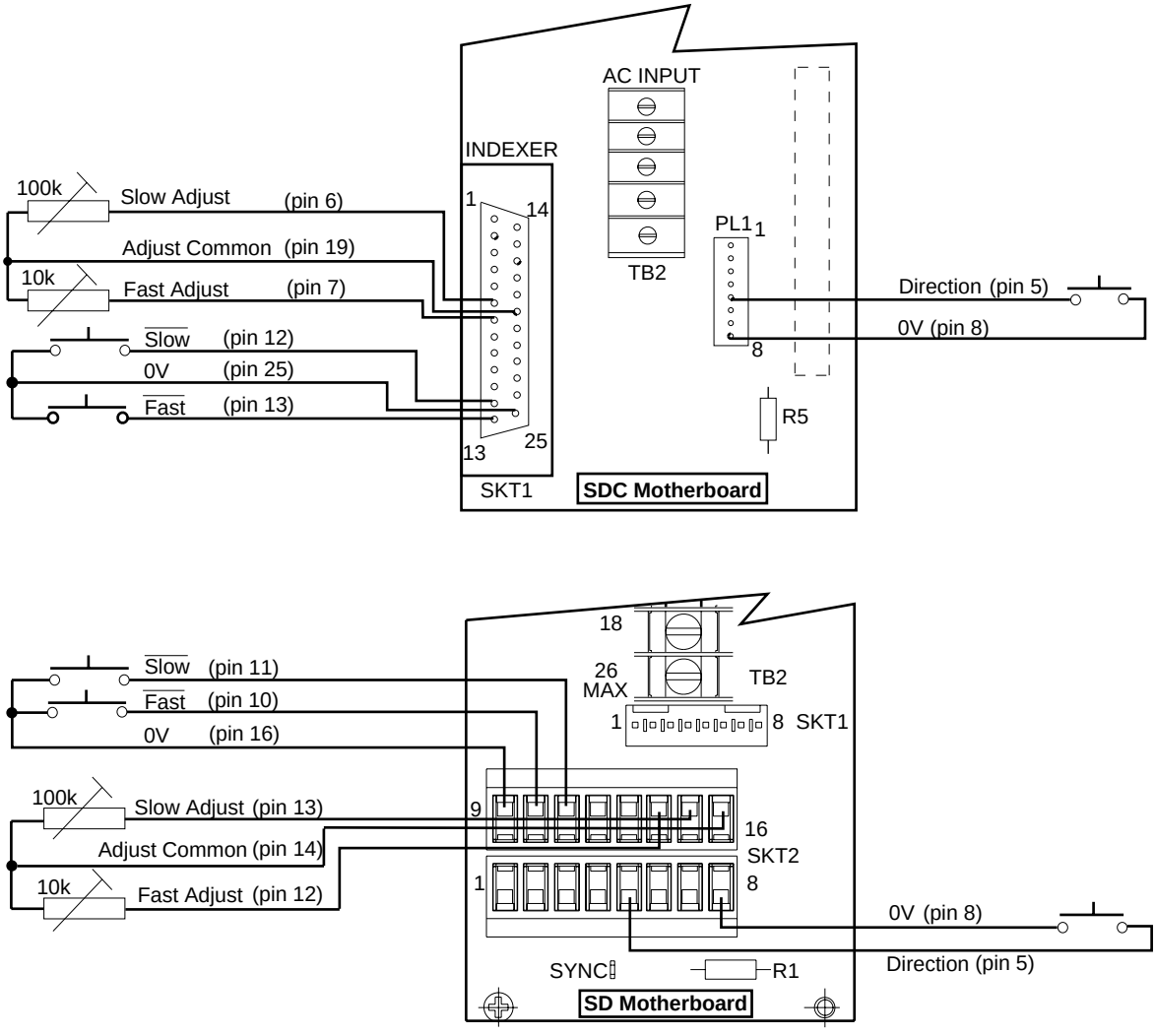


Figure 15. Optional Remote Advance Pot and Switch Connections

Environmental Considerations

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). Refer to the manufacturer's environmental specifications for the maximum motor case temperature when it is in operation.

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

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

Power Loss

The following power loss figures can be used to determine overall heat dissipation of the drives:

Drive	Power Loss
SD12	18W
SD13	22W
SD15	33W

Note: These figures assume the drives are operating at a 60V DC bus voltage, at maximum current.

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.

System Mounting

You should give special attention to the environment and location in which you will operate your drive system. Consider atmospheric contamination and temperature around the drive before you install and operate your system.

SD Drives are designed to be operated in a maximum ambient temperature of 50°C (122°F). They must be mounted either horizontally with the components uppermost or vertically as shown in Figures 19 and 20. **Do not** use inverted vertical mounting, i.e. with the links at the top of the board.

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 realisable.

External enclosures

The measures described in these recommendations are primarily for the purpose of controlling mains conducted emissions. To control radiated emissions, all SD drives and rack systems must be installed in a steel equipment cabinet which gives 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. Drives and filters must be in electrical contact with the panel to which they are mounted. If the panel has a paint finish, it will be necessary to remove the paint in certain areas where required.

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.

SC and SR Series Racks

These racks are designed to house SD series drives and are fitted with opto-isolated motherboards (SC series) or non-isolated motherboards (SR series). The use of the isolated SC series is strongly recommended, particularly if the control signal source is remote from the rack.

For EMC-compliant installation, both these rack systems can be fitted with an earth bonding strip running across the back of the rack (see Figure 16). This is for the bonding of screened motor leads and transformer feed leads to the rack system. The rack metalwork is also earth-bonded to this tie bar. The tie bar is available from Digiplan Part SC/CC - EMCKIT.

External enclosure

It is not necessary to fit front panels to the drives if the rack system is wholly contained within the enclosure. However, if a 19” case is used with no door or cover in front of the rack, then all drive front panels must be fitted.

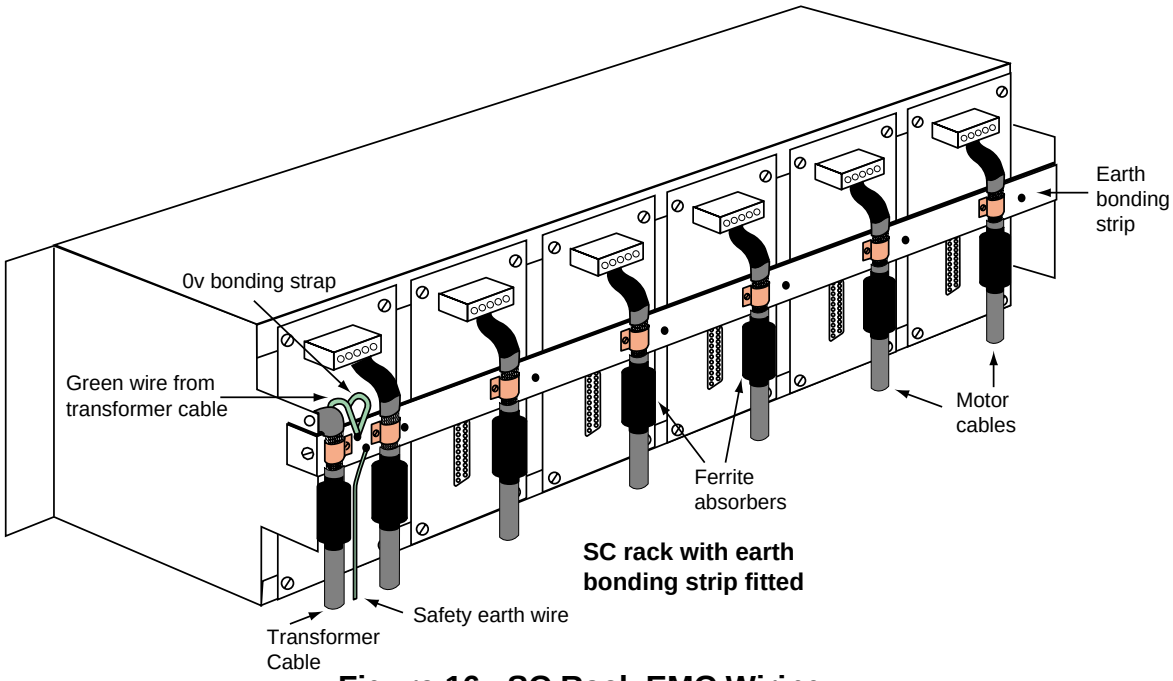


Figure 16. SC Rack EMC Wiring

Filtering the AC mains supply

A filter must be installed between the incoming AC supply and the mains transformer. A suitable filter is Corcom 10VV1. Mount the filter within 50mm of the transformer as shown in Figure 17. 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.

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 Figure 16).

No more than 5 metres of 5-core 1mm^2 screened cable (with a braided screen) should be used between the transformer and the left-hand drive motherboard in the rack (looking at the back of the rack). Use a green wire for the 0V connection. At the transformer end run the 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 rack, keep it away from the input cable to the filter.

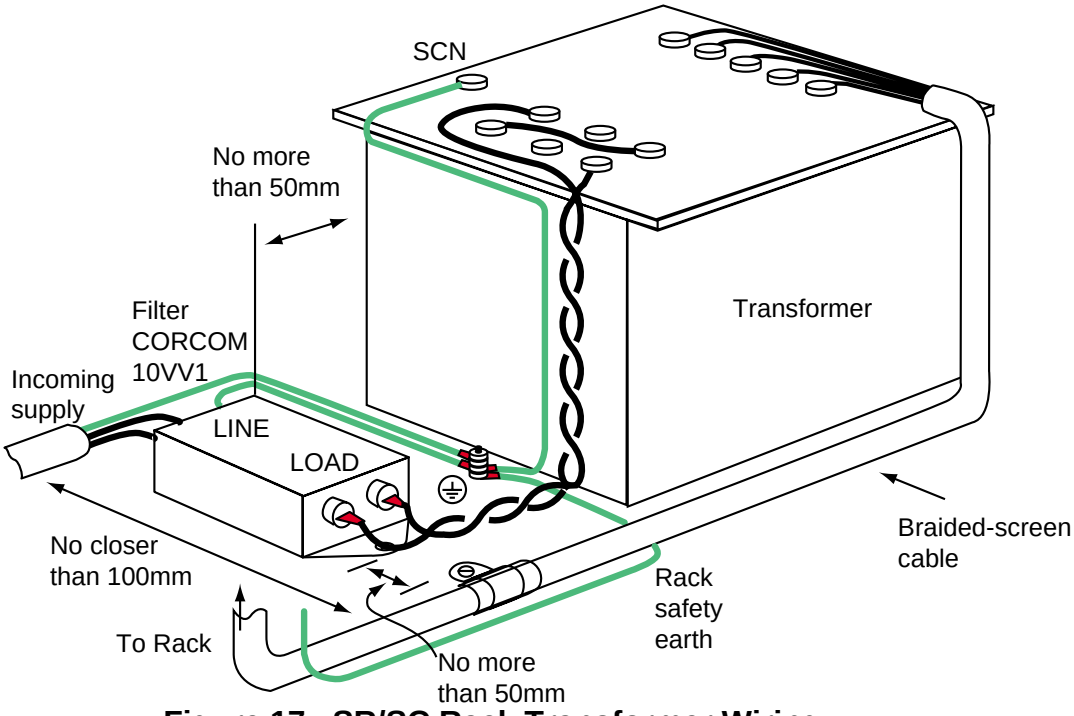


Figure 17. SR/SC Rack Transformer Wiring

At the rack end, fit a ferrite absorber over the cable and connect the appropriate wires to the V_m and 18V AC terminals on the motherboard. Remove the existing M4 brass earth stud, together with the earth wire connecting it to the first motherboard. Next fit the earth bonding strip to the rack end plates using the second hole down from the top. When fitting the bonding strip, use spring washers underneath the nuts and tighten securely - this is to ensure continuity between the bonding strip and the rack metalwork. Reconnect the earth wire from the first motherboard to the M4 stud on the earth bonding strip.

Route the transformer cable over the earth bonding strip and identify the location of the mounting point for the P-clip (refer to Figure 15). Expose approximately 12mm of the braided screen at this point and anchor the cable to the bonding strip. Locate the absorber 15-25mm from the P-clip using heat-shrink sleeving. Connect the green 0V wire from the transformer to the M4 stud on the bonding strip, together with a 2.5mm^2 green/yellow safety earth wire. Run this wire alongside the screened transformer cable back to the earth stud beside the transformer.

Motor Connections

The recommended gauge for SD drives is 1mm^2. Use a cable containing five conductors plus the braided screen, the fifth (green) wire being used to provide a safety earth return to the drive. Termination at the motor must be made using a 360° bond to the motor body, and this may be achieved by using a suitable clamp. Many stepper motors are designed to accommodate an appropriate conductive terminal gland which can be used for this purpose.

At the rack end, prepare the end of the cable as shown in Figure 18 and fit a ferrite absorber. Anchor the cable screen to the earth tie bar using the P-clip behind the corresponding drive. Connect the four wires from the motor windings to the appropriate terminals on the motor connector (please refer to the SD User Guide). Attach the green (earth) wire to the tie bar adjacent to the P-clip holding the braided screen using a ring terminal. (Terminal 3 on 5-way motor connectors should not be used as a safety earth since the connector can be unplugged without the use of a tool).

If the motor cable is more than 4 metres long, a separate safety earth connection will be required since the impedance of the 1mm^2 wire inside the screened cable will be too high. Use a 2.5mm^2 cable connected to the motor body and terminate it on the tie bar next to the P-clip for that axis. Run this cable close to the screened cable from the motor. If there is no suitable termination point on the motor body, remove the paint from the area of one of the mounting bolts and use an appropriate ring terminal. When a separate safety earth connection is used, the earth wire in the screened cable may be connected to terminal 3 on the 5-way motor connector.

The non-isolated SR rack is fitted with 4-way motor connectors. In this case the safety earth connection is always made to the tie bar.

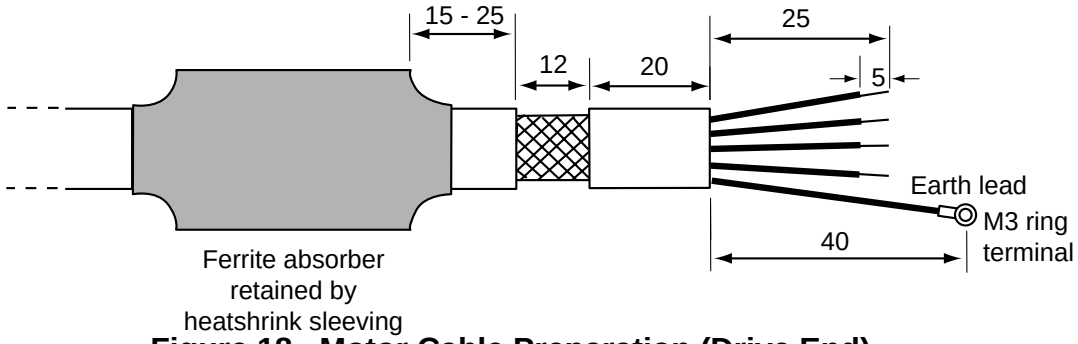


Figure 18. Motor Cable Preparation (Drive End)

Control signal wiring

To ensure adequate immunity it is necessary for control circuits leaving the enclosure to be adequately screened, with the screen of the cable bonded back to the tie bar on the rack. Cable with a braided screen should be used, not metallised foil, and should consist preferably of twisted pairs to minimise magnetic coupling. It is strongly recommended to use opto-isolated drive motherboards where the controller is mounted outside the main enclosure.

Where screened leads are used in control circuits that are only opto-isolated at one end, the screen must be referenced to earth at the non-isolated end. When using an SR rack with non-opto-isolated motherboards, bond the screen to the earth tie bar close to the corresponding drive.

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.

SETTING UP

Complete System Configuration

Drive functions are set by means of links. These are factory-set to provide optimum operation in most applications. You may, however, need to alter these settings to satisfy the particular operating requirements for your application. Take care, unexpected motion may occur at any time, especially during the commissioning of motion control equipment.

Warning - Electric shock hazard

Links must not be changed until power has been removed from the drive for at least 8 minutes.

NOTE: To change link settings you must remove the drive from the rack.

SD Drive Links

A 14-way pin header is located on the component side of the board (see Figure 19). Four jumper links allow you to select a number of drive operating options, including the setting of output current supplied to the motor. To access the links, remove the screws securing the front panel to the rack and pull the drive from the rack.

***NOTE**: When re-installing the drive, make sure the drive follows the guide rails in the rack.*

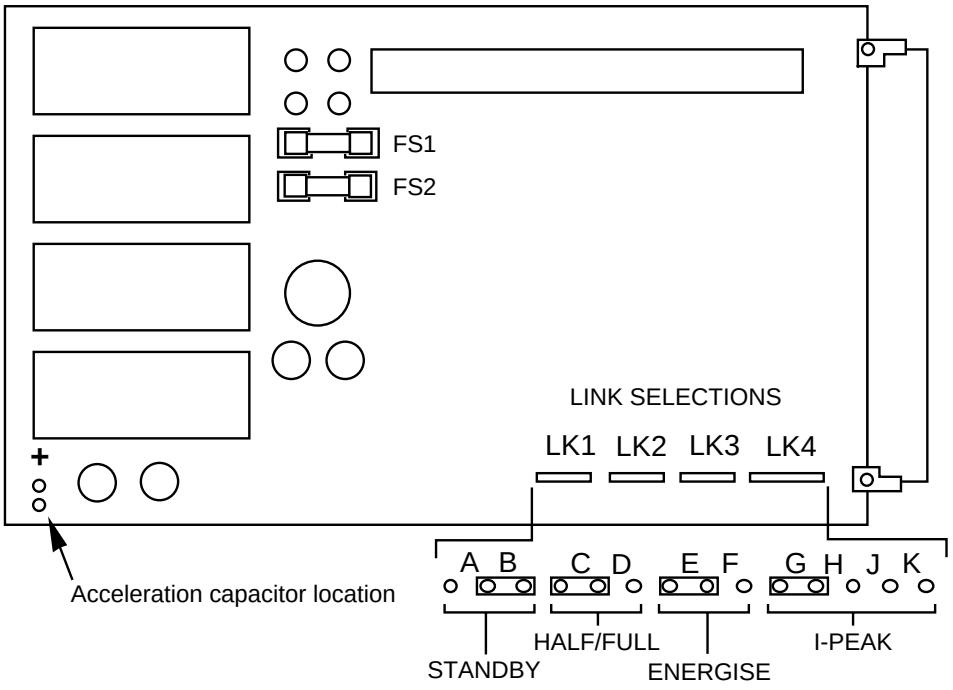


Figure 19. SD Drive Link Locations

SD Drive Link Settings

The SD Drive is fitted with four links (see Figure 19 for link locations) which may be fitted between certain pins of the 14-way pin header. Table 9 provides a summary of link options and the various positions they may occupy.

LINK	POSITION	FUNCTION	COMMENTS
1	A	Standby OUT	no standby current selected
	B	Standby IN	50% standby current selected
2	C	HALF	half stepping
	D	FULL	full stepping
3	E	Energise	motor permanently energised
	F	Remote Energise	motor energised via control signal
4	See Table 10		

Table 9. Drive Link Settings

Link LK1

With LK1 in the ‘A’ position no supply current reduction is selected when the motor is stationary. With LK1 in the ‘B’ position the supply current is reduced by 50% when the motor is stationary. Always use standby reduction (position ‘B’) where possible.

Link LK2

With LK2 in the ‘C’ position the drive will function in the half-step mode, producing 400 steps/rev, in the ‘D’ position full stepping is selected, producing 200 steps/rev. The half-step mode is preferred in most applications, the slight torque loss being offset by smoother operation at low speeds.

Link LK3

With LK3 installed in the ‘E’ position, the drive will remain permanently energized and a Shutdown command signal will have no effect on the drive. When link LK3 is installed in the ‘F’ position, the Shutdown command will de-energise the drive.

Link LK4

Link 4 determines the motor current selection for each drive type, see Table 10.

LINK LK4 POSITION	MOTOR CURRENT		
	SD12	SD13	SD15
G	2A	3A	5A
H	1.8A	2.7A	4.5A
J	1.6A	2.4A	4.0A
K	1.4A	2.1A	3.5A

Table 10. SD LK4 Link Settings

Ministepping Drive Links

An 18-way pin header is located on the component side of the board (see Figure 20). Four jumper links allow you to select a number of drive operating options, including motor stepping resolution and the setting of output current supplied to the motor. To access the links, remove the screws securing the front panel to the rack and pull the drive from the rack.

***NOTE**: When re-installing the drive, make sure the drive follows the guide rails in the rack.*

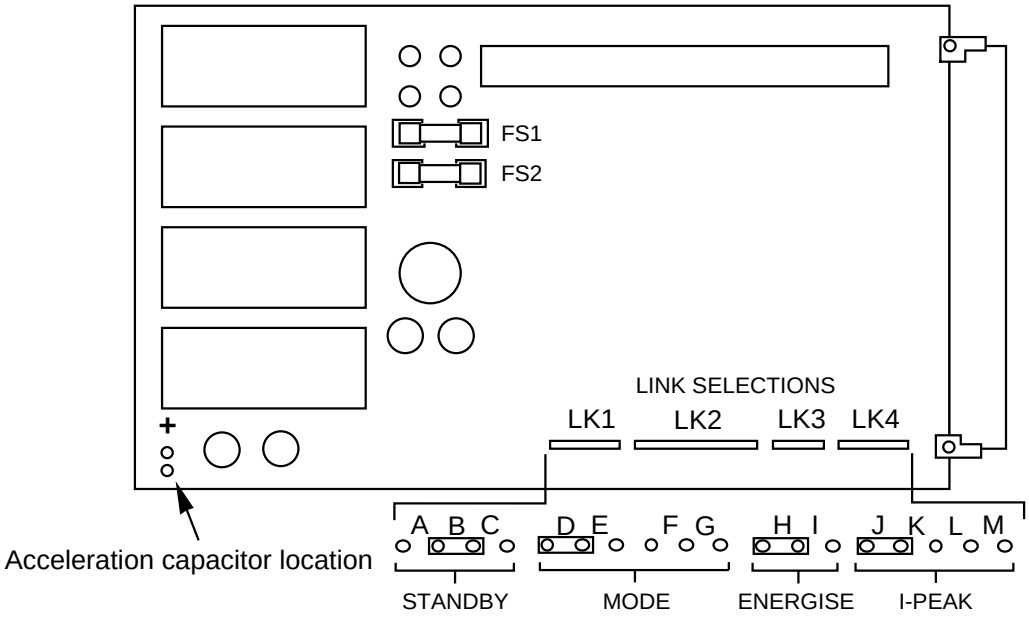


Figure 20. Ministepping SD Drive Link Locations

Ministepping Drive Link Settings

The Ministepping SD Drive is fitted with four links (see Figure 20 for link locations) which may be fitted between certain pins of the 18-way pin header. Table 11 provides a summary of link options and the various positions they may occupy.

LINK	POSITION	FUNCTION	COMMENTS
1	A	80% Standby	20% current reduction at standstill
	B	50% Standby	50% current reduction at standstill
	C	Reduced current	Permanent 50% current reduction
2	D	4000 step/rev	
	E	2000 step/rev	
	F	1000 step/rev	
	G	400 step/rev	
3	H	Energise	motor permanently energised
	I	Remote Energise	motor energised via control signal
4	See Table 12		

Table 11. Ministepping SD Drive Link Settings

Link LK1

With LK1 in the ‘A’ position there is an automatic reduction in current to 80% of its normal level when the motor is stationary. When LK1 is in the ‘B’ position the current is reduced by 50% when the motor is stationary. With LK1 in the ‘C’ position the current is permanently reduced to 50% of its normal level. The ‘A’ position is for increased holding torque (but with increased motor losses), ‘B’ is the normal position, and position ‘C’ should be used for very low current motors.

Link LK2

With LK2 in the ‘D’ position the drive will function in the 4000 steps/rev mode, with LK2 in the ‘E’ position the drive will function in the 2000 steps/rev mode, with LK2 in the ‘F’ position the drive will function in the 1000 steps/rev mode and with LK2 in the ‘G’ position the drive will function in the 400 steps/rev mode.

Link LK3

With LK3 installed in the ‘H’ position, the drive will remain permanently energized and a Shutdown command signal will have no effect on the drive. When link LK3 is installed in the ‘I’ position, the Shutdown command will de-energise the drive.

Link LK4

Link 4 determines the motor current selection for each drive type, see Table 12.

LINK LK4 POSITION	MOTOR CURRENT for SD15M
J	5.0A
K	4.5A
L	4.0A
M	3.5A

Table 12. Ministepping SD LK4 Link Settings

Factory Settings

Drive functions are factory-set to provide optimum system performance and safe operation. You do not need to alter these settings to accommodate the preliminary system operation and testing. Normally, these factory settings, with the exception of motor current, will satisfy the complete system operating requirements.

Factory Settings for SD Drive

The operating conditions for the SD Drive are factory set as follows:

- LK1 in position ‘B’ - 50% standby current selected.
- LK2 in position ‘C’ - Half stepping selected (400 steps/rev).
- LK3 in position ‘E’ - Drive permanently energised.
- LK4 in position ‘G’ - Maximum motor current selected.

Factory Settings for Ministepping SD Drive

The operating conditions for the Ministepping SD Drive are factory set as follows:

- LK1 in position ‘B’ - 50% standby current selected.
- LK2 in position ‘D’ - Ministepping selected (4000 - steps/rev).
- LK3 in position ‘H’ - Drive permanently energised.
- LK4 in position ‘J’ - Maximum motor current selected.

Acceleration/ Deceleration Rate Adjustment

The Fast and Slow set speeds are selectable by control lines connected into the motherboard.

The exponential acceleration and deceleration rates between the two set speeds are factory set to 60ms for accelerating from Slow speed to 95% of Fast speed, and 30ms for decelerating from Fast speed to Slow speed. These times may be increased by the addition of an extra capacitor on the drive module (see Figure 19 and 20 for location). See Table 13 for the range of acceleration and deceleration times obtained for a range of capacitor values.

Function	10µF	22µF	47µF	100µF
Acceleration	120ms	180ms	360ms	660ms
Deceleration	60ms	90ms	180ms	330ms

Table 13. Acceleration Deceleration Capacitor Values

A capacitor of minimum 16V rated voltage should be used. When fitting observe polarity.

SD Motherboard Settings

Links 1 and 2 on the SD Motherboard (see Figure 21 for link locations) are fitted in position 'B' to use the motherboard mounted preset controls RV1 (FAST ADJ) and RV2 (SLOW ADJ). When external speed controls are required, fit both links in position 'A'.

Advance Rate Adjustment

You can use the advance rate potentiometers to manually adjust the rate from 40 to 1,000 steps/sec (**SLOW** pot) or from 400 to 10,000 steps/sec (**FAST** pot). Refer to Figure 21 for the location of the fast and slow advance rate pots. For the Ministepping SD Drive the adjustment range will be from 3 to 135 rpm (**SLOW** pot) or 60 to 3500 rpm (**FAST** pot).

Turn the pot CW to increase the rate, and CCW to decrease the rate.

***NOTE**: If either the 'Slow' or 'Fast' rate is set too high the motor may stall.*

The internal oscillator should be used only if the indexer does not need to track the motor's position.

SDC Motherboard Settings

The SDC Motherboard is fitted with three links for selecting the use of the motherboard advance rate potentiometers or optional remote pots which you can connect via the 25-pin indexer connector (see Figure 22 for link locations). The factory default position for these links is position A.

Link LK1

Place link LK1 in position A to enable the advance rate pots on the motherboard. Place link LK1 in position B to disable the motherboard pots and divert the adjust common reference to pin 19 on the indexer connector.

Link LK2

Place link LK2 in position A to enable the slow advance rate pot. Place link LK2 in position B to disable the slow pot and divert the slow rate adjust signal to pin 6 on the indexer connector.

Link LK3

Place link LK3 in position A to enable the fast advance rate pot. Place link LK3 in position B to disable the fast pot and divert the fast rate adjust signal to pin 7 on the indexer connector.

Advance Rate Adjustment

You can use the advance rate potentiometers to manually adjust the rate from 30 to 1,000 steps/sec (**SLOW** pot) or from 600 to 20,000 steps/sec (**FAST** pot). Refer to Figure 22 for the location of the fast and slow rate advance pots. For the Ministepping SD Drive the adjustment range will be from 3 to 135 rpm (**SLOW** pot) or 60 to 3500 rpm (**FAST** pot) and is unaffected by the resolution selected, i.e. by the position of LK2.

Turn the pot CW to increase the rate, and CCW to decrease the rate.

***NOTE**: If either the 'Slow' or 'Fast' rate is set too high the motor may stall.*

The internal oscillator should be used only if the indexer does not need to track the motor's position.

Refer to ***Installation*** section for instructions to wire optional remote advance rate pots from the indexer connector.

Motor Current

For the SD Drive only as an alternative to using LINK 4 on the drive, you can reduce the motor current by installing a resistor in the R1 location on the SD Motherboard or R5 on the SDC Motherboard (see Figures 21 & 22). The motor current may be set by this resistor according to Table 14.

Nominal Current SD12	SD13	SD15	Resistor Value
2.0A	3.0A	5.0A	Open-circuit
1.9A	2.8A	4.6A	10KΩ
1.7A	2.6A	4.2A	4K7Ω
1.6A	2.3A	3.7A	2K7Ω
1.2A	1.9A	2.9A	1K2Ω
1.1A	1.7A	2.7A	1KΩ
0.95A	1.5A	2.3A	680Ω
0.8A	1.3A	1.9A	470Ω
0.65A	1.1A	------	330Ω
0.5A	------	------	180Ω
0.45A	------	------	100Ω
0.32A	------	------	82Ω
0.2A	------	------	S/C

Table 14. Motherboard R1/R5 Resistor Values for Setting Motor Current

R1 may be used to reduce the current level of an SD12 drive to 0.2A. The values of current given correspond to the condition when LINK 4 is in the "G" position. The current level should not be reduced below the lowest figure given for each drive variant.
The minimum motor current levels, in and out of standby, that the SD drives can operate at are shown in Table 15.

Drive Type	**Without Standby** (LK1 pos. "A")	**With Standby** (LK1 pos. "B")
SD12	200mA	400mA
SD13	1.0A	2.0A
SD15	1.7A	3.4A

Table 15. Drives Minimum Operating Current

Pre-installation Testing

A simple pre-installation test may be carried out on systems using the SD or SDC Motherboard to verify that the received system is functioning correctly. This section details the test and describes basic system configurations to test each drive-motherboard-motor set. See the section entitled ***Installation*** for final installation information.

The possible test configurations are:

1. Connecting to the drive via an SD motherboard using the on-board oscillator.

2. Connecting to the drive via an SDC Motherboard using the on-board oscillator.

Before starting any test make sure you have securely clamped the motor.

WARNING

Do not touch the AC input or motor terminals with power applied.

Test Configuration Using an SD Motherboard

Where interfacing to the drive is via an SD Motherboard, the system for pre-installation testing should be configured as shown in Figure 21.

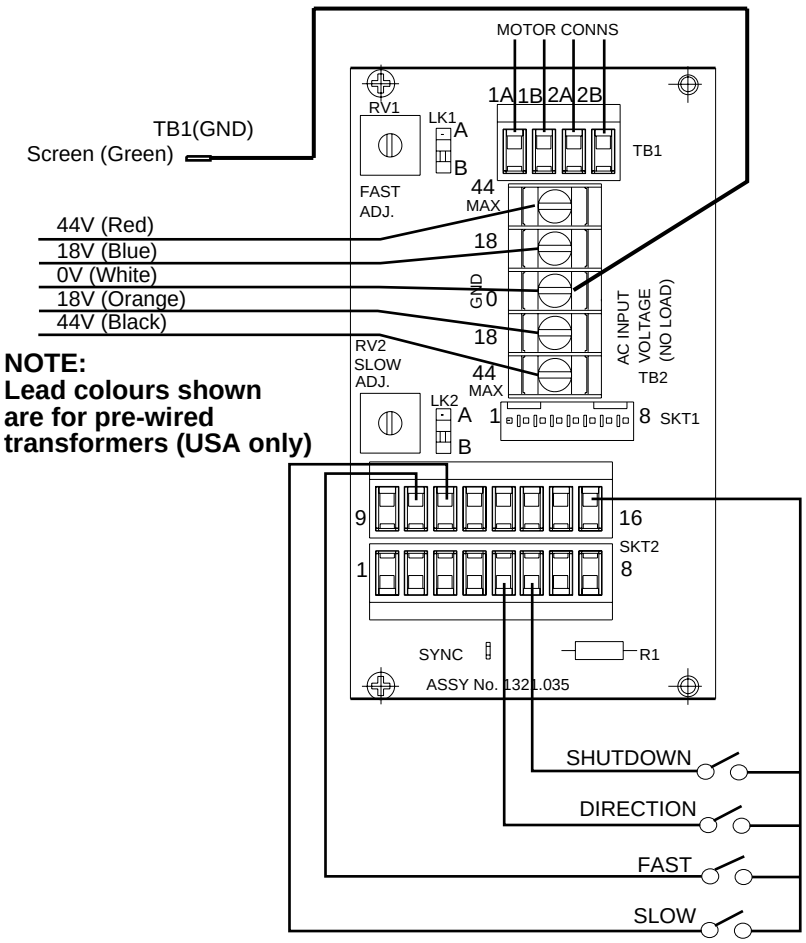


Figure 21 SD Motherboard Test Configuration

Test Configuration Using an SDC Motherboard

Where the SDC Motherboard is used in the system to connect to the drive, the configuration shown in Figure 22 may be used for the pre-installation test.

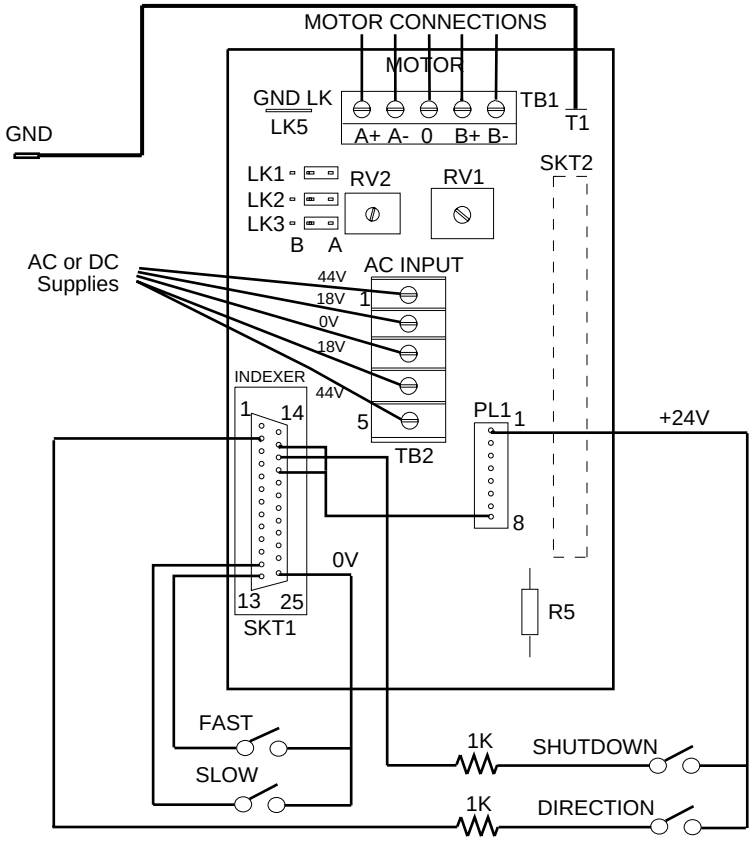


Figure 22. SDC Motherboard Test Configuration

Functional Test Without Indexer

This procedure uses the built-in clock facility in the drive to test the system where no indexer is available.

Step 1 Close the ENERGISE switch (SD Motherboard) or open the SHUTDOWN switch (SDC Motherboard) to energise the drive.

Step 2 Turn the SLOW potentiometer fully CCW and then press the SLOW button. The motor shaft should rotate slowly.

Step 3 Slowly turn the SLOW potentiometer CW and note that the speed of rotation increases.

Step 4 Release the SLOW button, close the DIRECTION button and then press the SLOW button keeping the DIRECTION button closed. The motor shaft should rotate in the opposite direction.

Step 5 Release both buttons. The shaft stops rotating.

Step 6 Turn the FAST potentiometer fully CCW then press the FAST button. The motor shaft should rotate faster than in Step 2.

Step 7 Turn the FAST potentiometer CW and note an increase in the shaft speed.

Step 8 Release the FAST button and close the SHUTDOWN switch.

If all of these steps have been completed satisfactorily the system is basically functioning correctly and may be properly installed.

MAINTENANCE & TROUBLESHOOTING

Maintenance

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

Routine maintenance is not necessary, but occasional checking of the following points is recommended.

Motor

You should inspect the motor to ensure that no bolts or couplings have become loose during operation. This will prevent minor defects from developing into more serious problems.

The ball bearings used in most stepper motors are permanently lubricated and do not require any maintenance.

You should inspect the motor cable or leads periodically for signs of wear. Do not attempt to stretch or force the cable around tight bends.

Drive

Check that the drive is free of loose particles and has a free flow of air over its entire surface. Enclosures must be connected to earth ground through a grounding electrode conductor to provide a low-impedance path for ground-fault or noise-induced currents. Check the security of the ground connections.

Trouble-shooting

This section discusses methods to identify and resolve problems that may occur with your SD Drive System or Ministepper SD Drive.

Problem Isolation

When your complete system does not function properly (or as you expect it to operate), isolate each system component and ensure that each one functions properly when it is run independently.

Use the following information to help in identifying the problem. If the problem persists, call one of the numbers at the front of this User Guide for engineering assistance.

Motor Fails to Move

Test the motor to see if it has holding torque. If there is no holding torque, here are some probable causes:

- There is no AC power.
- Current selection links are not set properly (see the motor current selection table 10 in the ***Setting Up*** section). *NOTE: If you have changed the current with resistor R1 or R5 make sure the current matches the motor's requirements.*
- There are bad connections or bad cables in the power supply circuit. Disconnect the power connector, then use a meter to monitor continuity between the power connector and the transformer and between the transformer and the rack.

- There are bad connections or bad cables in the motor circuit. Disconnect the power to the drive and remove the motor connector into the motherboard. Using a meter, check the continuity in the motor circuit between pins 1A/A+ and 1B/A- of the motor connector. Repeat for pins 2A/B- and 2B/B+.

- The drive may not be connected properly to the motherboard. Make sure the drive is securely plugged into the DIN connector on the inside of the motherboard.

- The shutdown input may be active or the energise input is not active.

- The drive fuses may be blown. Disconnect AC power from the drive, remove the drive from the rack, and inspect the line fuses FS1 and FS2, on the SD Drive card. **If either of the fuses are blown, return the system for repair.**

- Check the motor for damage. Also check the motor leads/cable to see if they are damaged or shorted. These conditions may cause the drive to fault out.

- Check the resistance of the motor and cables to make sure that shorts do not exist between phases or to earth GND. The resistance across each motor phase should be consistently low, and there should be no connection between motor phases and between each phase and earth ground.

If the unit has holding torque and the motor shaft still fails to move, here are some probable causes:

- The limit switches have been tripped or are faulty. Make sure that your limit switches are OFF or that the limits are disabled. These are a function of your indexer system, not the drive.

- The load is jammed. You should *hear* the drive attempting to move the motor. Remove AC power from the driver and verify that you can move the load manually away from the point of the jam.

- Indexer parameters are incorrectly set up. If certain parameters are out of range or are missing, the motor will not move when you issue the GO or START command.

Motor Stalls

A motor stall during acceleration may be caused by one or more of the following factors:

- The torque requirements may be excessive
- The acceleration ramp may be too steep - lower acceleration may be required
- The load inertia and rotor inertia may be grossly mismatched.

If the motor stalls during the constant velocity portion of a move, the shaft and/or coupler may be damaged or binding due to improper coupling or excessive motor load.

A stall may occur if the link setting for the motor current selection is incorrect. The motor may not be receiving enough current to drive the load.

A stall may also be detected in closed loop mode if the encoder resolution is not set properly, or if the encoder (where fitted) input channels (A and B) are reversed.

Motor Fails to Run at High Speeds

If the motor fails to run at high speeds, it is possible that the motor may not be producing enough torque to move the load at these velocities. Check the torque/speed curves in the *Digiplan Motion Control Catalogue* and make sure you are trying to run the motor within the system capabilities. High speed applications using 8 lead motors normally require the windings to be connected in parallel.

Motor is Jerky or Weak

Check that there are no mechanical problems at the load causing variable loading condition. Disconnect the motor from the load and run it without a load connected. Check the link settings (or programming resistor value) for proper current settings.

Motor Overheats

If the motor exceeds its maximum motor case temperature rating, failure will eventually result. Check your link settings (or programming resistor value) to ensure that the current setting is correct for the motor you are using. Refer to ***Setting Up***, for proper current settings.

Motor Shaft Develops Signs of Wear

The motor shaft may wear prematurely if there is foreign material rubbing against the shaft, or if the load is not coupled properly. Check couplings for tightness.

Reducing Electrical Noise

For information on identifying and suppressing electrical noise, refer to the Technical Data section of the *Digiplan Motion Control Catalogue*.

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).

Index

Accel/Decel capacitor values 42
Acceleration rate adj. 42
Advance pot. connections 29
Advance Rate Adjustment 42, 43
Auxiliary Indexer Connections 27
Auxiliary Indexer I/O 21
Auxiliary indexer specification 5

Bipolar rating 10
Board layout 37

Clock cards 27
Conducted emissions 31
Control signal wiring (EMC) 35
Current - minimum settings 44
Current selection - resistors 44

DC power connections 8
Deceleration rate adj. 42

Edge connector pin out 17
EMC Installation 31
EMC mains filter installation 32
EMI 9
Enclosure Considerations 30
Environmental Considerations 30
External controller supply 17

Factory Settings 41
Factory settings for Ministepping SD 41
Factory settings for SD 41
Fault LED circuit 28
Fault output reset 18
Fault output reset (SD) 25
Ferrite absorber handling procedures 35
Ferrite absorber specification 35

Grounding recommendations 9

Half stepping current reduction 3

Indexer - non TTL 27
Insulation rating of motor 11

Jog pots. 29
Jog switches 29

Line fuse type 10
Line fuse values 10
Link layout 37
Link Setting 38, 40, 51

Maintenance of drive 49
Maintenance of motor 49
Ministepping SD Drive links 39
Motor Cable 11
Motor Connections 11
Motor connections (EMC) 34
Motor current selection 38, 41
Motor Earth 11
Motor Fails to Move 49
Motor Fails to Run at High Speeds 51
Motor Insulation 11
Motor is Jerky or Weak 51
Motor Leads 11
Motor Overheats 51
Motor Selection 10
Motor Shaft Develops Signs of Wear 51
Motor Stalls 50
Motors 4-6-8 leads 10
Mounting recommendations 30

NEMA 30

Optional Advance Rate Pot and Switch Connections 29

Parallel connections 16
Power connections 7
Power dissipation - limiting 11
Power Dump 4
Power dump calculation 4
Power dump dissipation 4
Power dump option 4
Product Description 1
Product range 1

QM106-178 Motor wiring 12
QM106-205 Motor wiring 13
QM106-250 Motor wiring 14

Rack dimensions 1
Rack mounting 1
Rack tie bar 31
Radiated emissions 31
Reducing Electrical Noise 51
Remote Advance Rate Inputs 21
Returning the System 52

S106-178 Motor wiring 12
S106-205 Motor wiring 13
S106-250 Motor wiring 14
SC Rack 31
SC-Series rack 2

SC/SR-Series Rack Configurations 2
SD Drive Connections 17
SD Motherboard connections 25
SD Motherboard Settings 42
SD15MD 4
SD15WD 4
SDC indexer specification 5
SDC Interface circuit 23
SDC Motherboard Connections 20
SDC Motherboard Settings 43
SDC PL1 interface circuit 24
Signal description - direct 17
Signal Descriptions 21
Single rail operation 8
Specifications of the SD Drive 3
SR Rack 31
SR-Series rack 1
Step Input 18, 26
Step input for ministepping 26
SD Drive links 37
System Mounting 30

Temperature - operating 30
Temperature - storage 30
Temperature of motor warning 11
Temperature rating of motor cable 11
Test configurations 45
Timing Diagrams 19
Transformer Primary Connections 10
Transformer primary wiring 9
Transformer VA ratings 9
Transformer Wiring 9
Trouble-shooting 49

Unipolar rating 10

Wiring Guidelines 9

Zero phase output 18
Zero phase output (SD) 26

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