Stepper motor controller
DSR 92-70 C

Product manual
Version 02/2007

As part of the product, you should keep the manual for the product's entire service life. Give the manual to the next owner or user of the product.

File DSR92-70C_E.***

Editions published to date:

Edition	Valid for	Description
07/2003	I01	First edition
06/2004	I02	Revision
11/2004	I03	Addition for idle current reduction
05/2006	I05	Changes for new hardware version
02/2007	I08	Current values adjusted

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1 Overview

In this chapter

This chapter provides an overview of how the DSR stepper motor controller works. The following issues are addressed:

- The DSR's device concept
- Other components
- Block diagram
- Manual
- Guarantee

1.1 The DSR device concept

Overview

On the basis of the step and direction of rotation input variables, the DSR stepper motor controller produces motor current to operate a 2-phase stepper motor.

The DSR's most important characteristics include:

- bipolar output stage switching
- micro-stepping capability
- reduction in current when idle

The motor currents of the DSR can be adjusted to between 0.3 A_{eff} and 5 A_{eff} (30 % more with boost) using a rotary switch. This corresponds to a maximum peak current in micro-stepping mode of approx. 9.2 A.

At a supply voltage of between 40 and 80 V DC, the controller supplies regulated motor phase currents. It is designed to operate a 2-phase hybrid stepper motor from the Danaher Motion product ranges. This can be either a standard hybrid stepper motor or a high-performance hybrid stepper motor based on the patented Sigmax® principle. Motors with 4, 6 and 8 conductors can be used.
Note: *The output current of the DSR must be suitable for the rated current of the motor winding or it must be possible for this to be adjusted.*

Characteristics

Bipolar chopper output stage - The pulse width modulated 4-phase chopper output stage electronically regulates the motor winding currents at a chopper frequency of 20 kHz. This results in high suppression of the opposing electromotive force with a low ripple rectified current.

Other advantages include:

- reduced heat loss
- low electrical interference level
- improved micro-stepping capability

Micro steps - Can be set using a switch: Step widths of 1/1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/125 and 1/2.5 of a whole step when the 'step precision' input is active and 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128 and 1/5 of a whole step when the input is not activated. (See page 24.)

Circuit protecting against short circuits and shorts to earth - This deactivates the controller as soon as a short circuit or short to earth occurs at the motor outputs. The error can be deleted by switching the controller off and on again or by activating the 'Reset' signal.

MOSFET power transistors – These allow for a chopper frequency of around 20 kHz and eliminate noise that often occurs during rectification.

Signal connections with a large input range - The inputs are designed for voltages of up to max. 30 volts. The logic of the 'step', 'direction of rotation', 'disable', 'boost' and 'reset' input signals can be changed using the top plug-in jumper J1. The DSR has two open collector outputs: 'error' and 'home position'.
The aim of this section is simply to provide an overview. You will find details in Chapter 4 – Commissioning

Settings using DIP switch S1

Step width – Determines the step precision, i.e. how far the motor turns per step. One full step on the Pacific Scientific stepper motors corresponds to 1.8 degrees per step.
When the 'step precision' input is activated (L), the following step widths can be set: 1/1, 1/2, 1/5, 1/10, 1/25, 1/50, 1/125 and 1/2.5 of a full step.
This corresponds to 200, 400, 1000, 2000, 5000, 10 000, 25 000 or 500 (micro steps per revolution).
If the 'step precision' input is not activated (H), the following step widths can be set: 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128 and 1/5 of a full step.
This corresponds to 400, 800, 1600, 3200, 6400, 12 800, 25 600 or 1000 micro steps per revolution.

Idle current reduction (ICR) - Activates or deactivates the idle current reduction which reduces the motor winding current to 40% (20%) of its set value when the motor is stationary. The reduction in current takes effect 0.05 seconds after the last step impulse (presetting). The DIP switch can also be used to set this delay to 0.1 or 1 second or to deactivate it. The current returns to 100 % of the set value during the next cycling impulse.

Settings using rotary switch S2

Motor current – Sets the motor phase current to 0.3/0.6/0.9/1.2/1.5/1.9/2.2/2.5/2.8/3.1/3.4/3.7/4.0/4.3/4.7/5.0 A_{eff}.
The front cover has to be removed to make the rotary switch accessible in order to set the current.

Settings using plug-in bridges

Configuration of inputs – The logic of the 'step' 'direction of rotation', 'disable', 'boost' and 'reset' input signals can be changed using the top plug-in jumper J1. These inputs have an internal pull resistor of 4700 Ohm. When logic is positive, this is linked to GND (otherwise +5V).

Configuration of error output– The central plug-in jumper J2 can be used to configure the error output as a normally closed contact or normally open contact.

Configuration of direction of rotation– The bottom plug-in jumper J3 enables the effect of the direction of rotation input to be inverted.

Typical applications

Typical applications for the DSR controller are e.g.:

- X-Y tables and carriages
- packaging systems
- robot technology
- special machines
- material supply
- labelling machines

1.2 Other system components

Overview

The other components which when combined with the DSR stepper motor controller form a complete unit are:

- pulse generator or indexer
- mains supply for a supply voltage (40-80 V DC)
- stepper motor

The installation instructions for these components can be found in chapter 2 'Installation of the DSR stepper motor controller'.

Block diagram

The following block diagram shows the basic installation of the drive in a typical system.

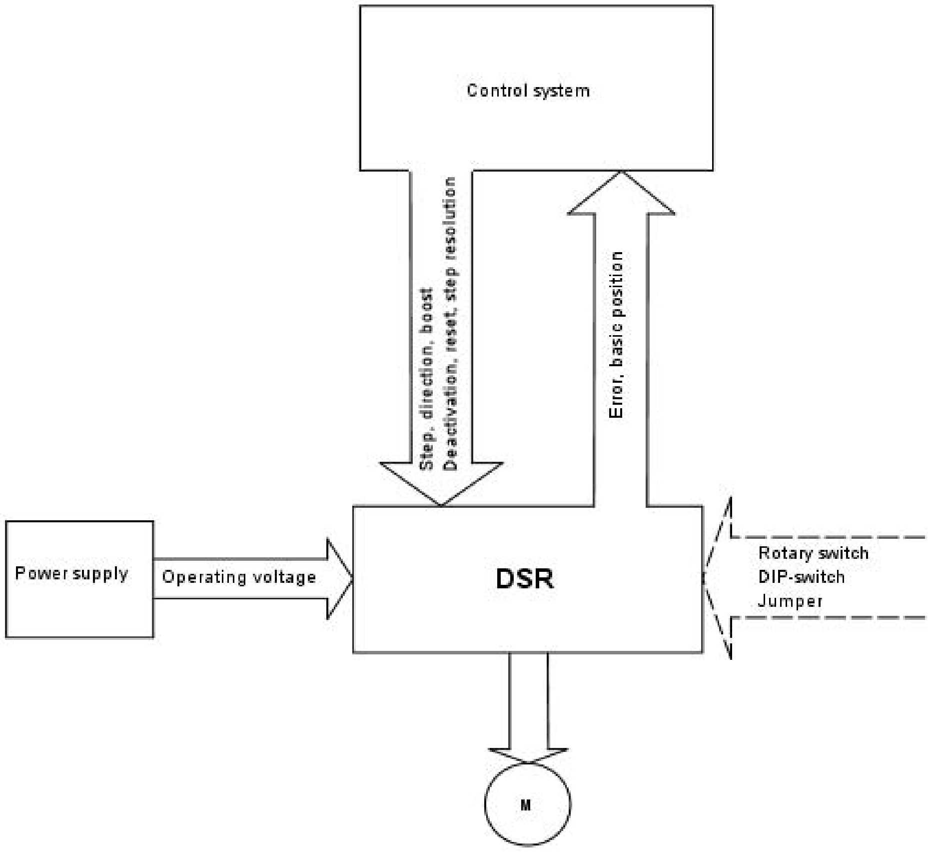


Figure 1.1

1.3 About this manual

This technical description contains information on how to connect and set the DSR stepper motor controller and information on how to remedy faults.

We would ask that you use the information provided here in the individual chapters and in Appendix B (about the mains supply) for planning your electrics, selecting or constructing a mains supply, installation and commissioning. This will spare you commonly made mistakes and avoidable problems.

1.4 Guarantee

Danaher Motion grants a **one-year guarantee** covering material and production faults for DSR drives. This guarantee does not however extend to devices which have been modified by the customer, subjected to force or incorrectly used in any other way (e.g. connected incorrectly, switches set incorrectly etc.)

1.5 Manufacturer's declaration

DANAHER MOTION

EC Declaration of Conformity

The company

Danaher Motion GmbH
Robert Bosch Straße 10
D-64331 Weiterstadt, Germany

declares that according to the EC Machinery Directive 89/392/EWG, Annex II B, the following component

Step Motor Drive

Type DSR 92-70-C

is intendend solely for fitting into a machine/electrical device. Commissioning is prohibited until the conformity of the machine/electrical device in question is also in compliance with the EC Machinery Directive.

The above indicated component is in conformance with the following directives:

89/336/EEC	Electromagnetic Compatibility (EMC)

The following harmonized standards have been applied:

EN 50178	Equipment of high voltage installations and electrical devices

Instructions concerning set-up, commissioning, operation and maintenance are part of the technical description and have to be followed.

Issuer	Danaher Motion GmbH Dipl.-Ing. Bernhard Wührl
Place, date	Weiterstadt, 08.03.2007
Legally binding signature	

2 Installation

In this chapter

This chapter describes how to install the DSR stepper motor controller. The following issues are addressed:

- incoming goods check
- safety information
- selection of extra system components
- mechanical assembly of the DSR
- connecting the DSR up to an electrical supply

2.1 Checks upon receipt

Check

When you receive it, inspect the device and its packaging for any damage which may have arisen during transport. When accepting the device, any damage found must be noted by the carrier on the consignment note.

If you find any concealed or obvious damage, document these and inform your carrier immediately. (Post: no more than 24 hours after delivery)

Take the DSR out of the transport box. Remove all packaging material from the device.

Check the content against the delivery slip. A sticker on the device's PCB cover will tell you the device type, serial number and date code.

Storing the device

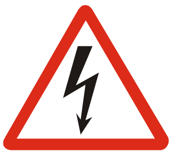
Once you have checked the device, store it in a clean dry place. The storage temperature must be between –55 °C and 70 °C. To prevent damage during time spent in storage, repack the device into its original box.

2.2 Safety information

Your responsibility

As the project planner or user of this device you are responsible for establishing that the product is actually suited to the applications for which you intend to use it. Under no circumstances will Danaher Motion assume liability or responsibility for indirect damage or follow-on damage which may be caused by incorrect product use.

Note: *Read this entire manual so that you can operate the DSR device effectively and safely.*



WARNING!

The voltages present in the DSR are high enough to possibly give a person a dangerous electric shock.

Observe the following safety information to prevent such a thing happening.

Safety information

In order to avoid personal injury when working with the DSR device, note the following:

- Never operate the stepper motor controller without the front cover being earthed.

  Note: *If the DSR is operated without a front cover, then at least one mounting block must be earthed*.

- Never connect anything up to the internal circuits of the DSR!
  The input and output terminals and/or connectors on the backplane are the only reliable and safe connection points.

- Always deactivate the voltage supply before making or breaking connections on the device.

- Be careful with the motor terminals when they are disconnected from the motor. If the drive is energised when the motor is not connected up, these terminals will carry a high voltage even if the motor is disconnected.

- Activating the 'disable' input is not a safe way of disconnecting in an emergency. To safely deactivate the drive, always interrupt the voltage supply as well.

2.3 Selecting other system components

Selecting a pulse generator

The DSR controller needs the step and direction of rotation signals to be specified. Select a pulse generator or an indexer which provides these signals at the very least. A suitable indexer must be able to control the input circuits described in section 3.1.3. Most applications requiring speeds of more than 100 rpm need a pulse generator or indexer which reaches the pulse frequency by means of a ramp function.

Selecting a motor

The DSR controller is designed to operate a 2-phase hybrid stepper motor from the Danaher Motion product ranges. This can be either a standard hybrid stepper motor or a high-performance hybrid stepper motor based on the patented Sigmax® principle. Most 2-phase stepper motors from other manufacturers are also suitable.

Note: *The motor current of the DSR must be adjusted to make it suitable for the rated current of the motor winding.*

Contact your local Danaher Motion distributor for the drive configuration and for advice on selecting a motor.

Selecting the mains supply

A mains supply with just one supply voltage is needed to operate the DSR. The voltage supply may be between 40 and max. 80V DC. If all the DSR's power is needed, a maximum current of approx. 6.5 A must be provided. A controlled mains supply is not needed.

IMPORTANT INFORMATION

- ***The voltage supply must not (even briefly) exceed 85 V.***
  Non-observance may result in device defects. Take care when using switching mains supplies.
- ***When braking, motors return energy to the mains supply. This will increase the supply voltage.***
- ***You will find important information about the mains supply in section 3.1.2 and in Appendix B. Please read through these two sections carefully before selecting or building a mains supply.***

2.4 Mechanical assembly

Power losses

The levels of lost heat produced by the DSR controller depend on the motor current. The cooling system should be selected such that the maximum heat sink temperature of 85 °C is not exceeded.

The assembly site must be free of external jolts, vibrations and impact.

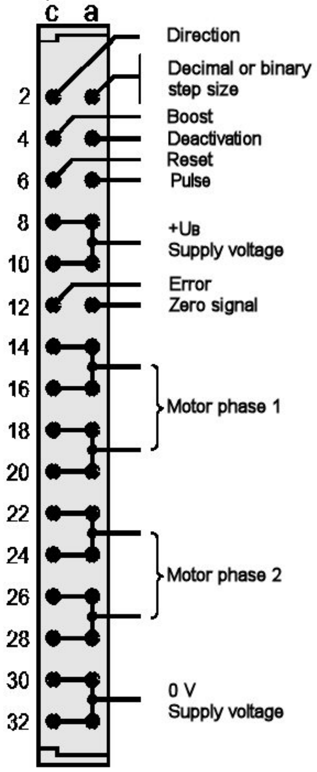
The maximum heat sink temperature of the device (85 °C) and maximum ambient temperature (40 °C) must be ensured.

3 Connection

3.1 Connecting to electrical supply

Introduction

The inputs and outputs on the VG male multi-point connector for use with the BP-DSR backplane are described in the following sections.



The cabling is application-specific

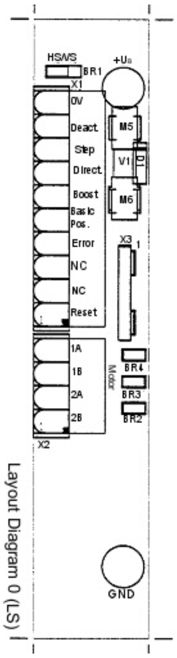
The wire cross-sections, means of connection and earthing/shielding measures described below are standard and are sufficient for most applications.

Note:
Unusual applications, possible valid special standards and regulations, special operating conditions and system configurations may require deviations from the information stated here.
These regulations take priority over the information provided here.
You may therefore have to connect up the drive differently from the descriptions provided here.

CE-compliant installation Earthing brackets

Use shielded and twisted cable for the signal and power cables as described below. This cautionary measure will reduce the chance of electrical faults. Place a well-earthed rail near the DSR stepper motor controller and use shielded brackets to apply the cable shielding to all of this. Continue the shielding up to the DSR. The length of cable between the earthing rail and DSR should not exceed 1 m.

Various manufacturers supply suitable components for the earthing rails and brackets. For example, Phoenix provide SK14 terminals, NLS-Cu 3/10 rails and the associated AB/SS-M assembly feet; Weidmüller supply KLBÜ shielding terminals.
The front cover of the DSR must also be linked conductively with PE. If the controller is operated without a front cover, at least one mounting block must be earthed. Below you will find a description of how to connect up the motor and control signals for the DSR-BP backplane.



Layout Diagram 0 (LS)

Risk of electric shock

Refer to section 2.2 with regard to the relevant safety information for reducing the risk of an electric shock.

3.1.1 Motor connection

Introduction

The motor cable links the backplane to X2 with motor windings. The mating connector is a plug-in screw terminal to simplify installation and to allow the connector to be plugged in and removed quickly.

System motors

If you use system motors (with MS round plug connectors) on which the mating connectors are already provided, then connect these up as shown - below:

5-pin Ms connector motor		**X2 BP-DSR motor connector**	
Pin	**Colour**	**Pin**	**Designation**
A	Black	3	1B
B	Orange	4	1A
C	Red	1	2B
D	Yellow	2	2A
E	Green		connect to PE

Note: *All wires 1.0 or 1.5 mm*^{2}.

Producing the motor cable

If you are producing a cable yourself, please follow the information provided below for connecting up the mating connector. Different ways of connecting up for different motor versions can be seen on the connection diagrams provided in this section. With 8-conductor motors, the windings of one phase are normally connected up in parallel. If you connect the motor windings in series, the motor's rated current is halved. The speed which can be reached is then lower due to the higher inductivity.

X2 connection table

OUTPUT	PIN	EXPLANATION
Motor phase 1A	X2-4	Excitation motor phase 1 (twisted pair of conductors)
Motor phase 1B	X2-3	
Motor phase 2A	X2-2	Excitation motor phase 2 (twisted pair of conductors)
Motor phase 2B	X2-1	

Mating connector

The X2 motor connector on the DSR-BP backplane is a plug-in Phoenix MSTB 2.5-4-ST RM5.08 screw terminal.

Requirements of the cable

Strands of up to 1.5 mm² fit in the terminals of mating connectors X1 and X2. It is better to have a larger wire cross-section (especially for longer motor cables) than required for the current so that the drop in voltage remains low. Always use a shielded cable with a wire cross-section of at least 1.0 mm² (or better 1.5 mm²) as the motor cable. If using motor cable lengths of more than 20 m, contact your distributor.

We would recommend cables comprising two pairs of conductors which are twisted about 1 to 1.5 times per centimetre and a fifth wire for the motor casing's earth. There must be a shield around both pairs of phases and the protective conductor. If using longer cables, we would recommend also shielding the two (twisted) wires of each phase again in pairs. IMPORTANT: Apply the shielding to all of the earthing rails mentioned above.

Note: *Firmly tighten the clamping screws to X2 for a good connection.*

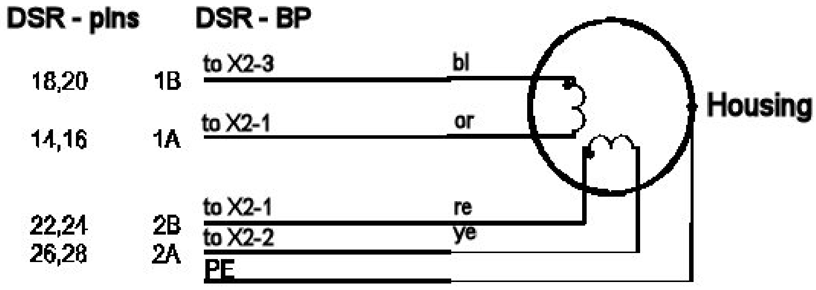
ATTENTION:
Do not solder the strand ends. Cold solder 'flows' under pressure and will result in a loose connection over time.

Connecting motors with loose cable ends

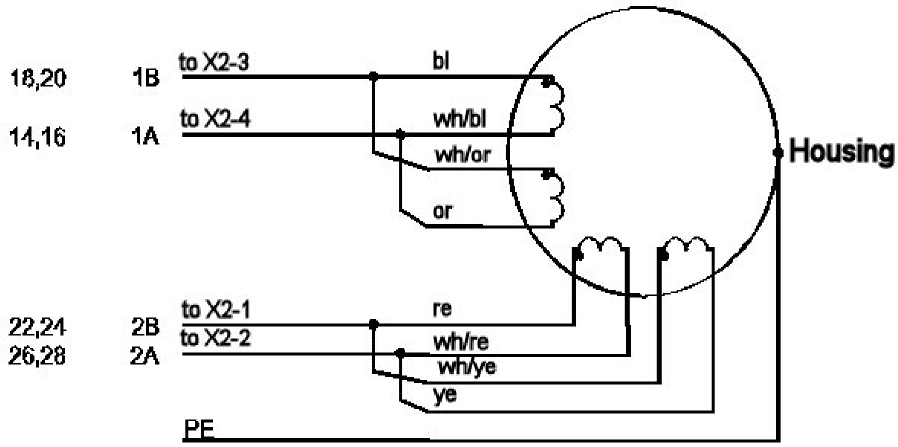
The 3 diagrams provided below show how a motor with loose cable ends can be connected to the X2 connector of the DSR-BP.

- The first diagram shows how to connect up a 4-conductor motor,
- the second diagram how to connect up an 8-conductor motor with windings connected in parallel,
- and the 3rd diagram how to connect up an 8-conductor motor with series connection of its windings.

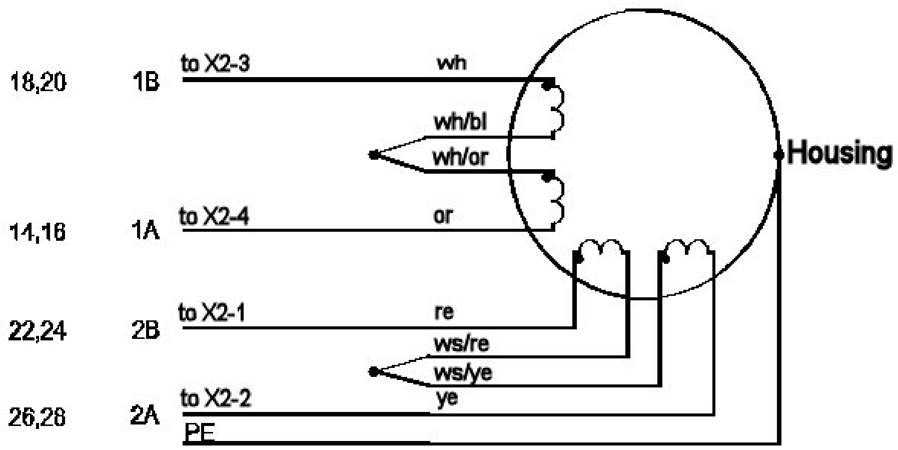
The links needed for parallel or series connections can be provided on the motors using e.g. terminals.



4-lead motor



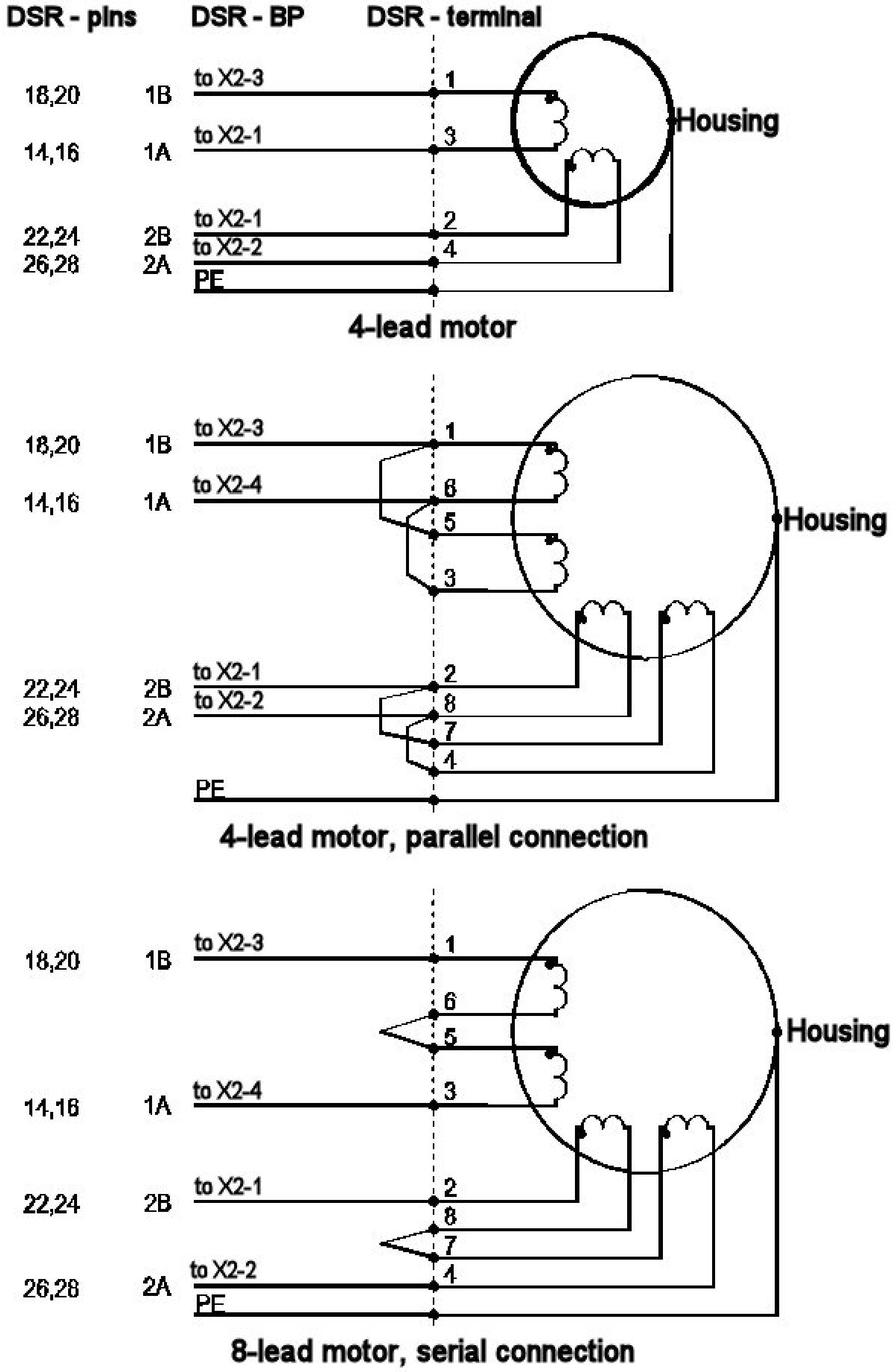
4-lead motor, parallel connection



8-lead motor, serial connection

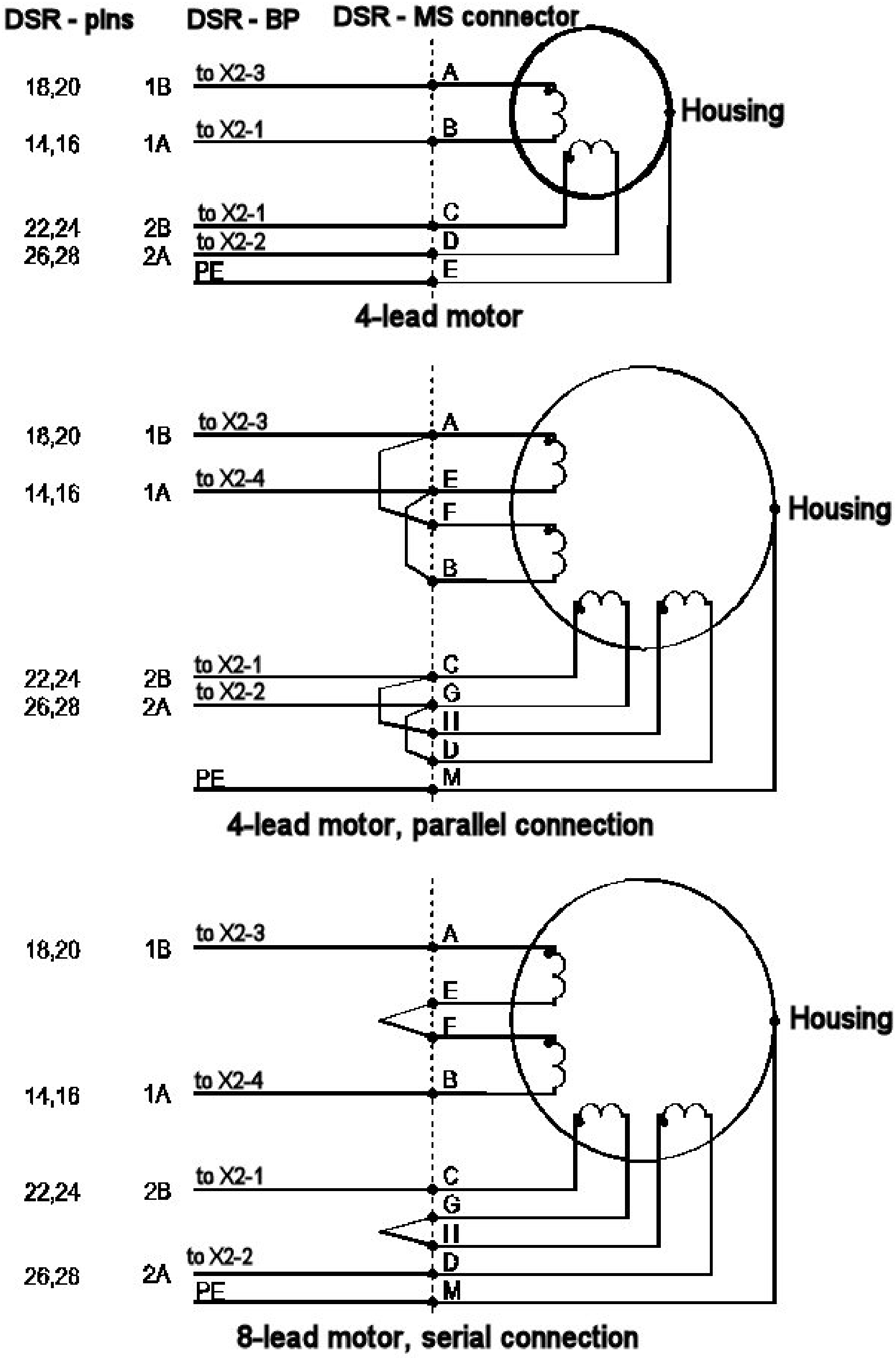
Connecting motors with terminal boxes

The figure provided below shows the connections needed between the X2 connector of the DSR-BP and stepper motors with terminal boxes on the rear motor -plate. The diagram shows connection of 4-conductor motors, 8-conductor motors with windings connected in parallel and 8-conductor motors with windings connected in series.



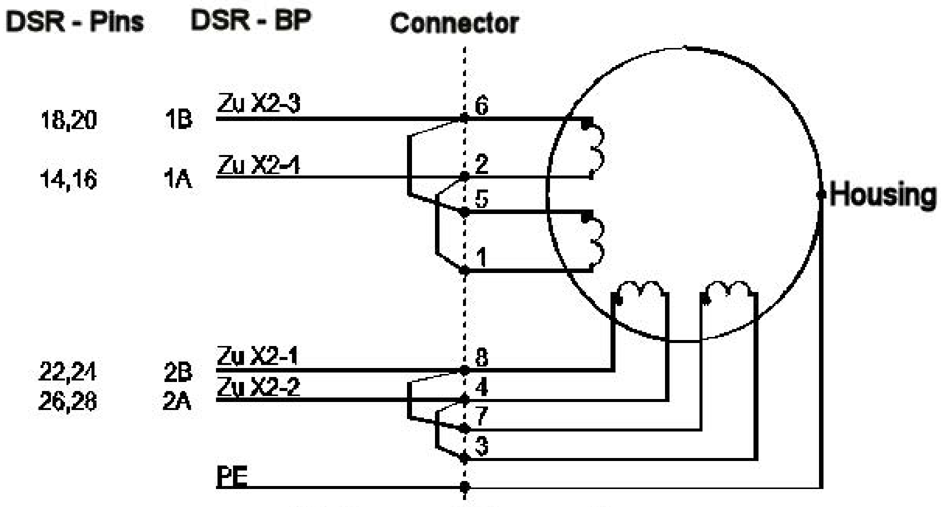
Connecting up system motors with MS connectors

The diagram shows the connections between the X2 connector of the DSR-BP and the stepper motors with MS round connectors.
The diagram shows connection of 4-conductor motors, 8-conductor motors with windings connected in parallel and 8-conductor motors with windings connected in series.

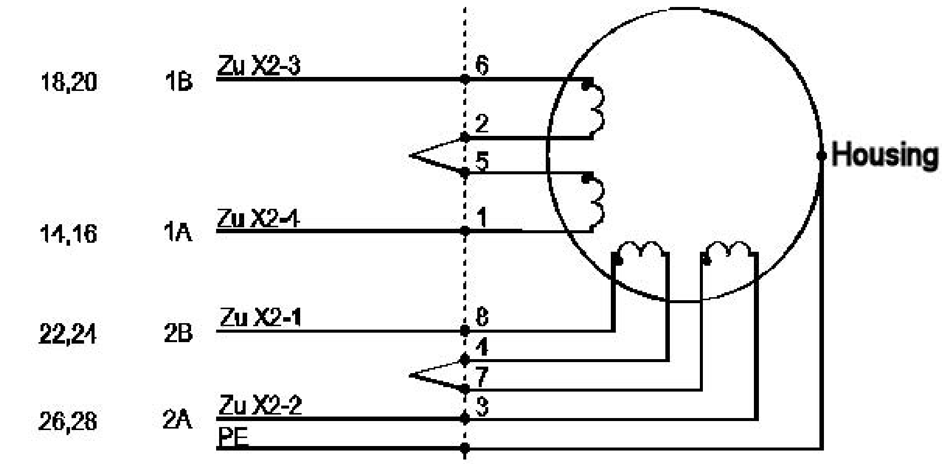


Connecting POWERMAX II® motors

The diagram provided below shows the connections needed between the DSR-BP and the POWERMAX II® motors require connections. POWERMAX II® motors have an 8-pin connector. As shown, the windings of a phase can either be connected in parallel or in series.



Windings, serial connection



Windings, parallel connection

3.1.2 Voltage supply

Introduction

The voltage supply from the mains supply (e.g.: MTB25) is supplied to the DSR-BP backplane at the two soldered pins. Refer to Appendix B for the requirements of a mains supply. Appendix B contains information on how to configure and build or select the mains supply.

Voltage supply

An uncontrolled, screened DC voltage is sufficient to supply the DSR.

DSR-BP	DSR pins	Explanation
$+U_B$	8a, 8c, 10a, 10c	Permissible voltage 40-80 V DC, max. 6.5A. The connection cables must be linked to all the DSR's pins.
0 volts	30a, 30c, 32a, 32c	

If you are producing your own backplane, fit a safety fuse for 10 A with a time lag between the mains supply and DSR (do not use an automat).

Requirements of the cable

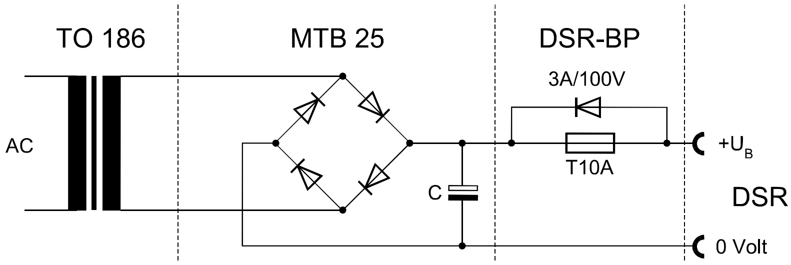
You can use a normal, shielded cable between the mains supply and backplane. If there is a greater distance between the mains supply and DSR, note the following.
A voltage stabilising capacitor should be fitted near the DSR. Use a twisted pair of wires for the link between the DSR and capacitor (twisted 1 to 1 ½ times a centimetre). The protective conductor wire should not be twisted. This link must not be any longer than 1 m. The 3 wires must be covered with a shielding netting. Use cable with a 1.5 mm² cross-section for the voltage supply. Apply the shielding to all of the earthing bracket.

IMPORTANT INFORMATION

The voltage supply must never, even briefly, exceed 85 V.
Peaks in the supply voltage (as may occur e.g. in switching mains supplies) are the most common cause of device failure.
The pulse width modulated chopper controller does not absorb its current evenly, but in pulses. The cable inductivity between the DSR and external capacitor is therefore very important. They must therefore be linked to one another by a twisted, shielded pair of conductors of no more than 1 m in length.

Example of connection

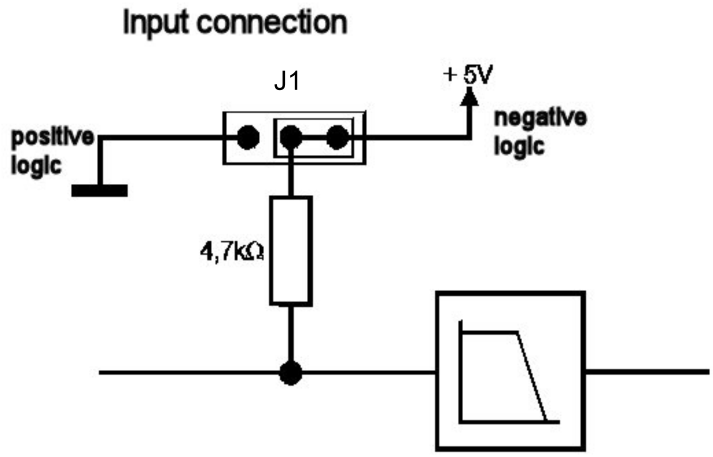
Note: *Shielding not shown.*

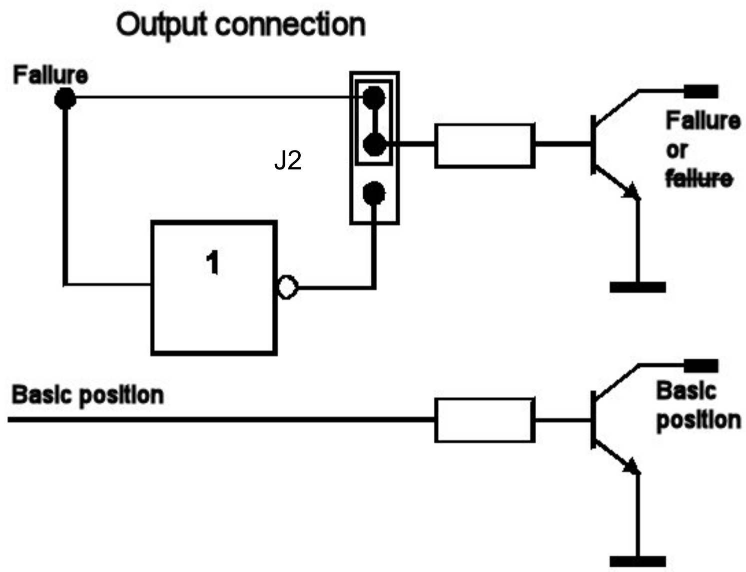


3.1.3 Signal connection

Introduction

The DSR is connected to the superordinate controller and motor via the VG connector. The DSR-BP backplane can be used for this purpose. The signal connections are then made via connector X1. The following diagram shows the basic input and output circuit of the DSR.





Mating connector

The signal connector on the DSR-BP X1 backplane is a plug-in Phoenix MSTB 2.5-10-ST RM5.08 screw terminal.

Input/output	DSR-BP	DSR pin	Explanation
Reset	X1-1	6c	The output stage is shifted into a defined output status. Any possible errors are deleted.
Error	X1-4	12c	Collective output for error messages (excess temperature, excess current) Setting as normally closed contact or normally open contact (jumper J2)
Home position	X1-5	12a	Home position signal after x steps. X = m/50; m = steps per revolution *Example: 1/5 step = 1000 steps* *A signal is produced every 20 steps.*
Boost	X1-6	4c	Increase in current by approx. 30%
Direction of rotation	X1-7	2c	Direction of motor movement
Step	X1-8	6a	Input for controlling motor rotation.
Disable	X1-9	4a	This input is used to approve or block the motor current. There is a time lag of approx. 500 µs between the drive being approved at the input and the power section being activated.
0 volts	X1-10	30ac 32ac	Reference point for input and output signals
Step precision	Jumper VS/HS	2a	Decimal or binary step width **The input must not be changed over during operations.**

Voltages of up to 30 V are permitted for supplying the DSR controller.

4 Commissioning

In this chapter

This chapter explains how the DSR drive is commissioned after installation. The following issues are addressed:

- Setting functions using plug-in bridges J1, J2 and J3
- Setting functions using the S1 and S2 switches
- Testing the installation

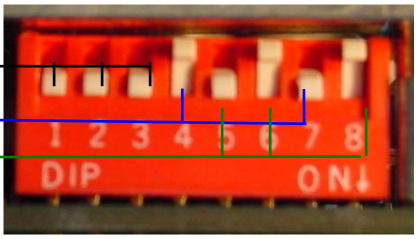
The aim of this chapter is to familiarise the user with the settings needed to commission and operate the DSR drive.

4.1 Setting DIP switch (S1)

Introduction

DIP switch S1 is used to set:

- the step width
- not used at present
- the idle current reduction



4.1.1 Step width (1-3)

Definition

Step width determines how far the motor turns on the input per step signal. This turn is specified as fractions of a full step in the following table. The decimal step width is selected when the 'step precision' input is activated (0 volts).

Position S1			**Decimal step width**		**Binary step width**	
1	**2**	**3**	**VS fractions**	**Steps/ revolution**	**VS fractions**	**Steps/ revolution**
ON	ON	ON	1/1 (VS)	200	1/2 (HS)	400
ON	ON		1/2 (HS)	400	1/4	800
ON		ON	1/5	1,000	1/8	1,600
ON			1/10	2,000	1/16	3,200
	ON	ON	1/25	5,000	1/32	6,400
	ON		1/50	10,000	1/64	12,800
		ON	1/125	25,000	1/128	25,600
			1/2.5	500	1/5	1000

Given the design of all Pacific Scientific stepper motors and all 1.8° stepper motors, the following applies: one full step causes the motor shaft to rotate through 1.8° degrees. Conversion into steps per revolution applies to this.
By combining the 'step precision' input and the DIP switch S1 in positions 1 to 3 (as listed), 15 step widths are available.

Advantages

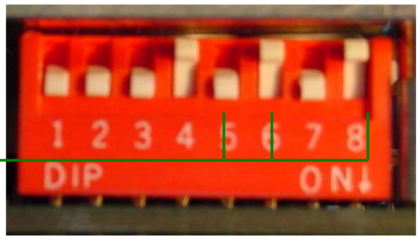
If you select a micro step width of 1/4 or less, you then have:
- greater precision
- a more constant operation at low speeds
- the option of operating the drive in resonance ranges at low speeds.

Consequence

Your indexer or pulse generator must also be able to issue the correspondingly higher pulse frequencies.

4.1.2 Idle current reduction (5,6,8)

Definition



Idle current reduction always reduces the phase current when the motor is stationary. The motor current is reduced as soon as step commands are not received for a specified period of time. This time can be 50ms (default), 100ms or 1 second.
The function can be blocked so that the holding current equals the operating current. From a thermal standpoint, that is however undesirable. Once approved, a time delay can be chosen to apply between the last pulse signal and the reduction in current taking effect. A longer delay is recommended for reverberating load. By combining the settings of DIP switch S1, (position 5 and 6), users can select between 4 options. They can also choose between two holding currents. If DIP switch S1, position 8 is set to OFF, the current is reduced to approx. 40% of the operating current. If the switch is in the ON position, the holding current is then only 20% of the operating current.

Position S1			Idle current reduction
5	6	8	
ON	ON	x	Function inactive
ON			40% effective after 0.05 sec.[1)]
	ON		40% effective after 0.1 sec.
			40% effective after 1 sec.
ON		ON	20% effective after 0.05 sec.
	ON	ON	20% effective after 0.1 sec.
		ON	20% effective after 1 sec.

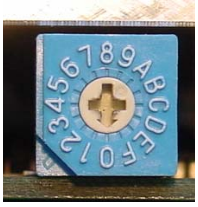
1) Default set in factory

> **Note:**
> ***When the idle current reduction function is active, both the holding torque produced by the motor and the motor's rigidity in the holding position are reduced.***

Advantages

The idle current reduction function reduces motor and drive heating when the motor is stationary and the limit stage approved.

4.2 Setting the motor current (S2)



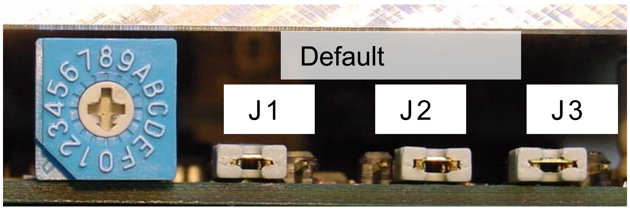
The motor current is set using rotary switch S2. Before undertaking the setting, you must deactivate the supply voltage and unscrew the front cover.
The current level set must be suitable for the motor's rated currents.
Connect up an 8-conductor motor in series, then please remember that now half the motor current of a motor connected up in parallel produces the same level of motor heating. The winding inductivity is quadrupled.

Switch position	Effective current in amps
0	0.3
1	0.6
2	0.9
3	1.2
4	1.5
5	1.9
6	2.2
7	2.5
8	2.8
9	3.1
A	3.4
B	3.7
C	4.0
D	4.3
E	4.7
F	5.0

4.3 Jumper setting

Logic

Jumper J1 can be used to select between positive (default) and negative logic.



Error output

The central jumper J2 defines whether the output acts as a normally closed contact (default) or normally open contact.

Preferred direction of rotation

The default for jumper J3 is a positive direction of rotation.

4.4 Testing the system

Background

The test stages described below test that the DSR controller has been installed correctly and check for concealed transport damage.

Procedure

Once the DSR has been installed as described in chapter 2, test the system as follows:

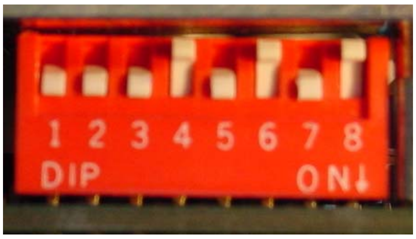
WARNING!

Errors may result in undesirable motor movements.
Therefore:

- **the motor shaft must be free when first switching on, i.e. no load may be connected up.**
- **attach the motor mechanically such that it cannot fall over or cause other damage if jolting movements are experienced.**
- **interrupt the voltage supply if any undesirable movements occur.**

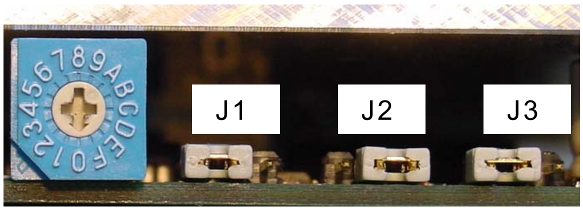
Checking connections

1. Check for correct assembly and check cooling, all cable connections, earthing points and shielding to ensure correct installation.
2. With the voltage supply off check whether positions 1 to 8 are set correctly on DIP switch S1.
   The default setting from the factory is shown here:
   - Step width: full or half step
   - Current reduction after 0.05 s



3. Check for correct assembly and check cooling, all cable connections, earthing points and shielding to ensure correct installation. The default setting from the factory is shown here:

   The settings have the following meanings:
   - positive logic
   - error output as normally closed contact
   - pos. direction of rotation



4. Set the current rotary switch to the motor's rated current and no more.
5. Activate the voltage supply.

Testing signals

1. Check whether the motor has holding torque by attempting to turn the motor shaft by hand. An active motor cannot be turned or can only be turned with great effort.
2. Specify the cycling impulse and check whether the motor turns.
3. Reverse the polarity of the direction of rotation signal and specify the steps for the motor. The direction of rotation must change.

Help If you require more assistance during usage, please contact your distributor.

5 Maintenance/error rectification

In this chapter

This chapter includes maintenance and error rectification for the DSR.

5.1 Cleaning the DSR controller

The DSR controllers do not need any regular maintenance. If need be the device can be cleaned as follows to prevent problems caused by an accumulation of dust and dirt:

Procedure

Use clean, dry, compressed (low pressure) air to remove any surface dust and dirt from the device.

5.2 Status LED

Green

After approval (motor activation), the LEDs on the front of the device light up green and the DSR is ready.

Yellow

If the LED lights up or flashes yellow, this indicates that the controller is receiving cycling signals.

Red

Error detection (see below) has been triggered.

5.3 Error rectification on the DSR drive

Introduction

The internal protective circuits establish the following errors:

- overcurrent at output
  (short circuit between two motor phases or one phase and earth)
- overtemperature

Once one of the aforementioned protective circuits has activated, an error is indicated by the status LED on the front of the device.
Use the following troubleshooting table. This tool will help you rectify most problems. If the controller cannot be operated, please contact your Danaher Motion distributor.

IMPORTANT INFORMATION!

If you come to the conclusion that the DSR is defective, do NOT simply replace the device with another one.

Instead check the following:

- ***the mains supply configuration.***
  You will find important information about this in Appendix B at the end of this manual.
- ***the type of wiring used for the voltage supply.***
  You will find important information on this in section 3.1.2 - Voltage supply – on page 21.
- ***whether the temperature of the heat sink has remained below 85 °C.***
  You will find important information about the thermal configuration in section 2.4 - Mechanical assembly – on page 13.

Incorrect voltage supplies are one of the most common causes of controller defects.

Troubleshooting table

OBSERVATION	MEASURES
Motor has no (holding) torque, and LED lights up red	Situation: An internal protective circuit has been activated and has removed approval. Switch off the voltage supply, disconnect the motor cable from connector X2. Check the motor cable for continuity, short circuits between the wires and short circuits between wires and shield. Check whether X2 is assigned correctly. Check the disconnected motor for continuity of the individual phases and for short circuits between the phases or between one phase and the motor casing. Reconnect the motor following one of the circuit diagrams shown in section 3.1.1 on page 15 onwards. Check whether the supply voltage is $\geq$ 40 V and $\leq$ 80 V DC. If possible, use an oscilloscope to check this and note any brief excess voltage or drops in voltage. Check whether the temperature of the heat sink is less than 85°C.
Motor has no torque, and LED lights up green	Situation: Controller is approved but there is too little or no motor current. Check whether the current setting is set correctly on the rotary switch. As described above, check whether the motor cable is wired correctly and plugged into the drive correctly.
Motor has holding torque, but is not turning. LED lights up green	Situation: No cycling signals are being detected at the step input. Test the step input, e.g. using a 4.5 V battery (with correct polarity). If an extremely small step width has not been selected, tapping several times must result in palpable motor shaft rotation. Ensure that the step input is wired correctly, and that its pulse source corresponds to the specific electrical and time requirements.
Motor turning in the wrong direction	Situation: You want to invert the direction of rotation input. Deactivate voltage. Swap the wires of one motor phase (not both) on X2. This will change the preferred direction of rotation.
Motor not responding to direction of rotation input	Test the direction of rotation input at a low pulse frequency, e.g. using a 4.5 V battery (with correct polarity). Ensure that the direction of rotation input is wired correctly and check whether the signal corresponds to the specific electrical requirements.

Continuation of troubleshooting table

<table>
<tr><th>OBSERVATION</th><th>MEASURES</th></tr>
<tr><td>Motor is not reaching the -
position expected.</td><td>Check whether the step width set on the DSR controller matches the step width for which parameters are set on your indexer.

Check whether the motor is therefore stationary or is losing steps because it is being overstretched by excess acceleration or load torque or because it is operating in the resonance range. Operating noises often provide good indicators.

1. Check the drive configuration again. Remember that the torque curve of a stepper motor depends on
- the intermediate circuit voltage of the controller (with the DSR controller, that is the supply voltage)
- the way in which an 8-conductor motor is connected (in parallel or series)

2. Use a smaller step width to prevent resonance problems at low speeds (under approx. 120 rpm).

3. If minor step errors are adding up when shuttling, then it is a good check to see whether your indexer is observing the necessary advance time (at least 50 µs) for direction of rotation signals before the first step of a new movement is output.

4. Check whether the signals at the cycling and direction of rotation input satisfy all the specific electrical and time requirements and that they are not being distorted by interference.</td></tr>
</table>

Return for repairs or Replacement

If you come to the conclusion that the DSR controller and/or stepper motor is defective, proceed as follows:
If you are a customer of a machine manufacturer in whose machines Danaher Motion products are used, please first contact the machine manufacturer, and not your nearest Danaher Motion distributor. Machine manufacturers often modify motors and the distributor will not be aware of this. As a result, replacement devices or motors will no longer be compatible even if the distributor supplies the same type number.

If you bought the products directly from a distributor, please contact this distributor. This distributor will be able to help you with rapid repairs and replacement.

6 Technical data

6.1 Electrical data

Spannungsversorgung 40 - 80 V DC, 6.5 A

Type of controller Bipolar two-phase chopper controller

Chopper-Frequenz nominal 20 kHz

Step width

Can be set using switch	Steps per motor revolution (1.8° stepper motor)
1/1 **(1/2)**	200 **(400)**
1/2 **(1/4)**	400 **(800)**
1/5 **(1/8)**	1000 **(1600)**
1/10 **(1/16)**	2000 **(3200)**
1/25 **(1/32)**	5000 **(6400)**
1/50 **(1/64)**	10,000 **(12,800)**
1/125 **(1/128)**	25,000 **(25,600)**
1/2.5 **(1/5)**	500 **(1000)**

Characteristics of signal inputs

Input		**Input level**			**Logic can be changed**
Step	Frequency	LOW	HIGH	Pulse width	yes
	0-100kHz	0-0.8V	3-24V	min. 2 µs	
	100-500kHz	0-0.3V	3-5.5V	min. 1 µs	
Direction of rotation		0 bis 2 V = LOW 3 bis 30 V = HIGH			yes
Disable		0 bis 2 V = LOW 3 bis 30 V = HIGH			yes
Boost		0 bis 2 V = LOW 3 bis 30 V = HIGH			yes
Reset		0 bis 2 V = LOW 3 bis 30 V = HIGH			Yes
Step precision		0 bis 1 V = dezimal open or 3 to 30V = binary			No negative logic

When the DSR is supplied, the logic is set to positive.

Characteristics of Open collector; max. 200 mA; U_{max} = 40 V

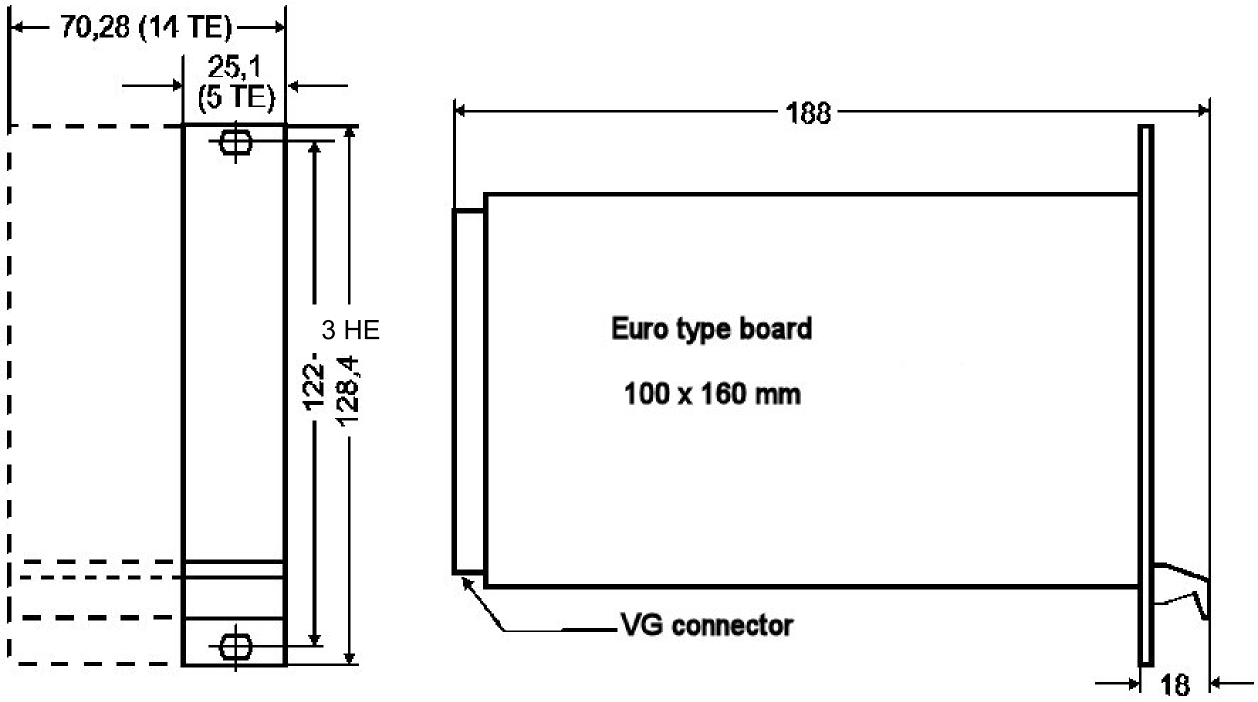
signal outputs	If inductivity (e.g. relays) is connected up as a consumer, the outputs must be wired with a recovery diode!
Maximum pulse frequency at step input	500 kHz
Advance time of direction of rotation input	If the direction of rotation is changed, in the 50 µs following the step input's level must not change.

6.2 Environmental data

Operating temperature	Permissible ambient temperature of 0 °C to 40 °C, provided that the maximum permissible heat sink temperature of 85 °C is not exceeded.
Storage temperature	–55 °C to +70 °C
Maximum heat sink temperature	85 °C **Note:** *A fan can be used to ensure this. If the idle current reduction function is used, less lost heat will be produced.*
Air humidity	10 to 90 %, condensation not permitted

6.3 Mechanical data

Dimensions



Weight	approx. 0.31 kg (not including front cover) approx. 0.34 kg (including DSR-FP front cover)

DSR-BP connector and mating connector

Voltage supply	Soldered posts
Signal	Phoenix Contact MSTBT 2.5/10-ST RM5.08
Motor	Phoenix Contact MSTBT 2.5/4-ST RM5.08

Appendix A - Order details

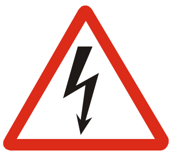
The type code and order numbers for the DSR controller and accessories are provided in this appendix.

Designation	Order number	Comments
Stepper motor controller	DSR92-70 C	Not including front cover
Technical description of DSR in German	01-MAEDSRC-D	01-MAEDSRC-D.pdf
Backplane	DSR-BP	
Front cover	DSR-FP	
Transformer	TO-186	
Mains supply	MTB25	For 4 DSRs and full current

Appendix B - Mains supply

B1 Mains supply consisting of jumper rectifier and capacitor

A mains supply normally consists of a transformer, jumper rectifier and capacitor. This kind of mains supply is most commonly used to supply one or more DSR controllers.
An isolating transformer secures the transformation at the level that, when rectified, provides the level of intermediate circuit voltage (DC bus) required. It also insulates from the mains. There should be individual fuses between the rectifier and each DSR. Their sizes should match the power requirement of the individual DSRs and therefore offer optimum protection. If there is a greater distance between the mains supply and DSR, capacitors must be fitted near each DSR. A twisted, preferably shielded pair of wires (no more than 1 m in length) must be used between the capacitor and terminals for U_B+ and 0 volts on the DSR. This limits the impact of line inductivity.
Sometimes a ballast circuit has to be used to limit the amount of voltage recovered from braking motors.
Appendix B contains guidelines on how to configure the mains supply's components.
It is essential that the shielding is stopped on the entire earthing rail.



ATTENTION

The mains supply must be configured such that the voltage never, even briefly, exceeds 85 volts <u>regardless of the operating conditions.</u> These conditions include maximum possible mains voltage, secondary voltage fluctuations caused by differing transformer loading, peaks in voltage caused by pulse-like current drainage by the DSR controller and recovered voltages when the motor is braking. Not taking these factors into account may result in permanent damage to the DSR controller.
Caution: peaks in voltage that damage the device may arise when using switching mains supplies!

B1.1 Configuration of the mains transformer

Mains voltage and frequency

When configuring the transformer, take into account the maximum possible mains voltage and the lowest possible mains frequency that may arise in your network. If this is not done, saturation, large rises in current and winding defects may occur.

Considerations relating to secondary voltage

The maximum motor rating can be reached at the maximum supply voltage whereby 85 V DC must never be exceeded.
A lower voltage can of course be used provided that there is a minimum voltage of 40 V DC. The lower the supply voltage, the more the available motor torque falls as speed increases.

The maximum voltage for the DC supply can be roughly calculated as follows (without taking peaks in voltage caused by the pulse-like current consumption of the DSR into account):

$$(1.414 \times \text{actual secondary effective voltage}) - 1.5$$

Note: *This assumes a drop in voltage of 0.75 V at each rectifier diode. We recommend fitting a discharge resistor at each capacitor to ensure this and to discharge the capacitors when the AC voltage is deactivated.*

Example

If the secondary voltage is effectively say 40 V AC, the maximum DC voltage is 1.414 × 40 – 1.5 = 55 V. A transformer with 230 V AC primary and 40 V AC secondary voltage would produce 55 V as the maximum voltage for the DC supply under normal mains conditions and rated load.

However, if the mains supply increases by 10 %, the peak voltage of the DC supply, with a rated transformer load, increases to:

$$(1{,}414 \times 1{,}1 \times 40) - 1{,}5 = 60{,}7 \text{ V.}$$

Transformer rigidity

When selecting a transformer, its rigidity must be taken into account. Transformers are designed such that they output their specified secondary voltage when loaded with the rated current.

The secondary voltage increases at currents below the rated current.
The details provided by 'Signal Transformer' for the rigidity of their transformers can be considered as typical:

Apparent transformer output	Increase in secondary voltage when idling as %
1 – 100 VA	+10 %
100 – 350 VA	+8 %
> 500 VA	+5 % and less

In other words, the secondary voltage of a 100 VA transformer when idling is 10 % greater than the specified rated voltage.

When configuring the transformer, consideration must be given to transformer rigidity as well as maximum possible mains voltage. For safety reasons, you should mainly use additional terminals to ensure that the permissible operating voltage is not exceeded. With single-phase transformers, this would for example be
0 – 230 V – 240 V - 250 V.

Calculating secondary end transformer rated voltage

Taking these considerations into account, the following table gives you the maximum rated secondary voltage for a mains with a voltage tolerance of +10%:

Apparent transformer output [1]	Max. transformer rated secondary voltage
1 – 100 VA	44,7 V AC
100 – 350 VA	45,5 V AC
> 500 VA	46,8 V AC

[1] Apparent transformer output in VA = secondary end transformer rated current × secondary end transformer rated voltage.

Calculating secondary end transformer rated current

The maximum current consumption of the DSR controller is basically a function of the output motor rating. The best approach is to use a measuring device to measure the DC current consumption of the DSR at maximum motor rating upstream of the capacitor.
Otherwise estimate: The maximum DC current consumption from the intermediate circuit will be roughly the same size as the motor phase current set on the rotary switch. If using several DSRs, add up the currents on one transformer. Take the coincidence factor into account.
Stationary axles have a lower current consumption when idle current reduction is activated.

Example:

The transformer configured to supply three DSR controllers with 5 A each should have a secondary end rated current of
$\times(5 + 5 + 5) = 15$ A.

Note: *Rough oversizing of the transformer should be avoided because this increases the activation surge in the capacitors and therefore subjects the rectifier diodes to increased loads.*

B1.2 Selection of rectifier diodes

Configuration

The I_{FSM} (max. permissible one-off current of the diode) of the rectifier diode must be greater than the in-rush current which charges the capacitors. (Capacitive load). It is common practice to select a limiting average on state current for the rectifier diodes I_{FAV} that is roughly twice the size as the secondary end transformer current.

Example

As above, there are three 5 A devices on the transformer:
Limiting average on state current $I_{FAV} = 2 \times 3 \times 5\ A = 30\ A$
block voltage: greater than 1.5 × intermediate circuit voltage 70 V = 105 V
$\Rightarrow$ *select jumper rectifier, e.g. KBPC3504 F/W type from Diotec, Heitersheim*
with the following data:
$I_{FAV} = 35$ *A ohmic, 28 A capacitive,* $I_{FSM} = 400$ *A,* $V_{RRM} = 400$ *V*
or another similar type.

B1.3 Selection of capacitor

The following capacitors should be fitted on the 50 Hz mains for approx. 10 % voltage ripple for each individual DSR:

Motor phase current	Intermediate circuit 30 V_{DC}	Intermediate circuit 50 V_{DC}	**Intermediate circuit 70 V_{DC}**
5.0 A	18,000 µF	10,000 µF	**7,500 µF**
4.375 A	15,000 µF	9,100 µF	**6,800 µF**
3.75 A	12,000 µF	8,200 µF	**5,600 µF**
3.125 A	11,000 µF	6,800 µF	**4,700 µF**
2.5 A	9,100 µF	5,600 µF	**3,600 µF**
1.875 A	6,800 µF	3,900 µF	**2,700 µF**
1.25 A	4,700 µF	2,700 µF	**1,800 µF**
0.625 A	2,200 µF	1,200 µF	**910 µF**

On a 60Hz mains, the capacitor may be approx. 20% smaller.

Ripple current

The capacitor's permissible 100 Hz ripple current should be same as or greater than the set DSR current.

Electrical strength

The capacitor's rated voltage must always be greater than the maximum DC voltage. Select a capacitor that is configured for at least 1.3 times the DC supply voltage you want.

Arrangement

The capacitor for every single DSR must be connected up using a twisted and wherever possible shielded pair of conductors no more than 1 m in length.

Discharge resistor

Connect a discharge resistor with a resistance of e.g. 5.1 kΩ, 2 W to every device via the capacitors.

B 1.4 Selecting fuses

Upstream of the DSR

If the motor current is set to 5 A $_{eff}$ fit a 10 A fuse with a time lag upstream of every DSR. Wird ein Motorstrom kleiner als 5 A. If a motor current of less than 5 A is set, the fuse value can be reduced proportionally.

Upstream of the Transformer

The mains transformer draws a high current at the second of activation. Select suitable tripping characteristics with a time delay for the upstream transformer fuse.

B1.5 Recovery

When a motor is braked, the motor converts the mechanical energy stored in the rotating motor and the rotating load into electrical energy and supplies this to the generator. The DSR controller can feed this energy back to the supply as voltage.

If the level of mechanical energy is less than the losses in the controller and motor, the supply voltage does not increase. However, if the mechanical energy is greater than the losses, the supply voltage increases and charges the capacitors. This increase is greater the higher the connected mass of inertia torque and the higher the speed.

The mechanical energy of a rotating mass is calculated using the following equation:

$$\mathbf{W_{kin} = \frac{1}{2} J \omega^2}$$

where W_{kin} = kinetic energy in Ws = joule

$\omega = \pi \times n/30$ circuit frequency in s^{-1}

n = speed in rpm

J = rotatory mass of inertia torque in kgm²

Voltage result

If this energy is converted into electrical energy in the form of load for the bus capacitor, the voltage is calculated as follows:

$$U = \sqrt{U_0^2 + \frac{2W_{kin}}{C}}$$

where

U = voltage (following the transfer of energy to the capacitors)

U_o = initial voltage

C = total capacity in farads

W_{kin} = initial kinetic energy in joules

Example

If an unloaded E34 motor (rotor inertia torque = 0.247×10^{-3} kgm² is running at a speed of 1500 rpm, the saved energy equals:

$$0.5 \times 0.247 \times 10^{-3} \times (\pi \times 1500/30)^2 = 3.0 \text{ joules.}$$

If all this energy is transferred into a capacitor at 6800 µF, which is initially loaded to 70 V, the voltage on the capacitor will then equal 76 V. This is below the maximum specified voltage for the DSR drive.

In reality, most or even all of the kinetic energy is consumed in the motor windings or in switching the controller, so that the voltage recovered often doesn't cause any problems. However, if you are working with higher speeds and a high load inertia torque, the voltage may rise considerably. Extra circuits must then be provided to ensure that the 85 V limit is never exceeded.

Note: *Recovered voltages may be critical if the mains voltage fluctuations are at maximum tolerance.*

To find out whether recovered energy is a problem or not, use a storage oscilloscope to monitor the supply voltage during operations. If necessary you can also connect a peak detector, consisting of a diode and capacitor, to the DC voltage and use a digital voltmeter to measure the peak voltage.
Rev up the motor and initially brake with a slight delay to see whether the voltage increases when braking. Do this several times and occasionally reduce the braking time. Observe the DC supply voltage. If the recovered energy increases the supply voltage to peaks of more than 80 V DC, a ballast circuit is needed.

Note: *Don't forget to take the maximum possible mains voltage into account during these tests.*

Ballast circuit

If a ballast circuit is needed, the simplest approach is to use an output breakdown diode as shown in the diagram. The ballast circuit must fully intervene at 80 V.

ATTENTION

When using a breakdown diode or another form of ballast circuit, the transformer's secondary voltage must be checked again to ensure that the ballast circuit is not intervening when maximum mains voltage occurs and the transformer is not loaded.
If this happens, the breakdown diode or other form of ballast circuit will get too hot and fail.

Breakdown diode

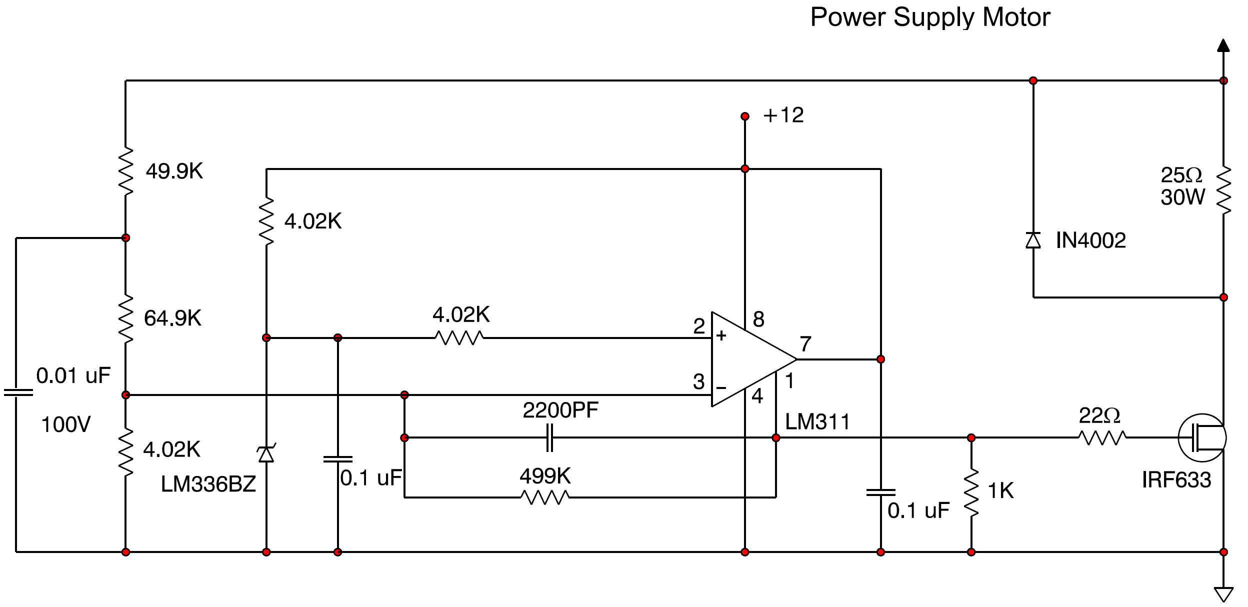
Use at least 5 W breakdown diodes whose breakdown voltage is less than 80 V and greater than the maximum possible intermediate circuit voltage.
Breakdown diodes can also be connected in series, the breakdown voltages are then added up.

WARNING !

The breakdown diodes can get hot! Leave sufficient space around them!

Active ballast circuit

If the average output is so high that it cannot be easily broken down in a breakdown diode, the active ballast circuit described below can be used instead. The output is broken down in a resistor of 25 Ω and 30 W when the motor's voltage supply exceeds 75 V. If the voltage supply exceeds 75V, this results in the ballast circuit being destroyed.



B 2 Electronically controlled mains supply

The DSR controllers draw current from the supply in pulses with steep flanks. Some controlled DC supply voltages are not appropriate for such applications.
If you experience problems, connect a voltage stabilising capacitor of 470 µF into the supply line to the DSR between $+U_B$ and 0 volts.
The capacitor must be able to smooth 20 kHz current ripples.
Its rated voltage must be at least 1.3 times the max. intermediate circuit voltage.
Fit one capacitor as close as possible to each DSR (no further than 1 m away in all cases) and twist and shield the wires to the DSR.

Controlled current supplies cannot normally feed energy back to the mains. The energy recovered when the motor is braking can therefore increase the intermediate circuit voltage and damage the current supply (or DSR). Fit a suitable output breakdown diode here too. If the ratings are high, an active ballast circuit will be needed.

B 3 Complete mains supplies available

Danaher Motion can provide you with various mains supplies and rectifiers for test configurations and tests. These are transformers with a fitted sheet metal bracket holding the rectifier and capacitor. The mains supplies issue a nominal 65VDC of uncontrolled screened DC voltage. The intermediate circuit voltage is so low that a ballast circuit is not normally needed.

B 3.1 Mains supply 0.386 kVA - order number TS65-5

Technical data forTS65-5:

Primary: 0 - 230 - 240 - 250 V~
Secondary: wired with jumper rectifier and 4700 µF and 2200 µF capacitors, 100 V
produces DC voltage of 65 V_{DC}, 5 A
Power: 325 W
Protection type: IP 00
Frequency: 50/60 Hz
Following EGS EN 61558-2-6

B 3.2 Mains supply 0.741 kVA - order number TS65-10

Technical data forTS65-5:

Primary: 0 - 230 - 240 - 250 V~
Secondary: wired with jumper rectifier and 4 x 2200 µF capacitors,
produces DC voltage of 65 V_{DC}, 10 A
Power: 650 W
Protection type: IP 00
Frequency: 50/60 Hz
Following EGS EN 61558-2-6

B 3.3 Mains supply MTB-25
order number MTB3-25-85-012-AA or MTB3-25-85-012-AB

We can also provide you with the MTB-25 rack mains supply which is suitable for when using your own supply.

Technical data of MTB25:

Rated connection voltage:	1 x 85 V_{eff} (40 V_{eff} ... 95 V_{eff})	
	3 x 85 V_{eff} (40 V_{eff} ... 95 V_{eff})	
Rated output voltage:	U_{VCC}=120 V_{DC} (55 V_{DC}... 140 V_{DC})	
	(=intermediate circuit voltage)	
Rated output current:	8 A_{DC} (1 ~), 25 A_{DC} (3 ~)	
Rated output power:	960 W (1 ~), 3 kW (3 ~)	
Ballast circuit:	Impulse power	3.2 kW
Permanent power:	500 W	
	Activation threshold	UVCC> UIN ´ + 5 V
	External ballast resistor	9 Ohm, 500 W
Connections:	VG connector acc. to DIN 41612, 32-pin, series a+c equipped, shape D	
	Internal ballast resistor*:	Peak power 650 W
	Permanent power without enforced ventilation 30 W	
	Permanent power with enforced ventilation 60 W	
Auxiliary voltage 24 V_{DC} *:	Rated input voltage	1 x 19 V_{eff} oder 3 x 19 V_{eff}
	Rated output voltage	24 V_{DC} (20 ... 28 V_{DC})
	Rated output current	2 A_{DC} (1 ~), 3 A_{DC} (3 ~)
	* only with MTB25-AB	

Order number for mains supplies:

MTB-3-25-85-012-AA (standard)
MTB-3-25-85-012-AB (with option of external 24V and internal brake resistor)

Order number for backplane:

MB-MTB-03
More information can be found in the MTB25-D flyer, rev 05-00

List of key terms

P

R

S

T

V

W

Sales and service

We can offer you a competent and rapid service. Select the regional sales branch responsible in Germany or contact the European or North American customer service team.

Germany

NORTH sales area
Danaher Motion GmbH
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