Stepper Motor Controller
DSM9-SD-XX

Product Manual
Edition 11/2007

Keep all product manuals as a product component during the life span of the product.
Pass all product manuals to future users/owners of the product.

DANAHER MOTION

File dsm9-sd_e.***

Record of Revisions:

Edition	Remarks
12/2006	Preliminary edition
06/2007	First edition
11/2007	New mating connector

Technical changes to improve the performance of the equipment may be made without notice !
Printed in Germany

Contents

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1 DSM9 summary

In this chapter

This chapter provides a summary of the functionality of the DSM9 stepper motor controller. It covers the following topics:

- General concept of DSM9
- Other system components
- Block diagram
- Manual
- Guarantee

1.1 General concept of the DSM9

Summary

The DSM9-SD stepper motor controller accepts input signals as pulse frequency and direction information, and uses them to generate the power outputs for the motor currents to operate a 2-phase stepper motor.

The most important features

- bipolar power output stages,
- micro-step capability, as well as
- a current reduction at standstill.

Motor Current

- can be set by DIL-switches within a range from $0.4A_{eff}$ to $6.4A_{eff}$ (9A peak current in micro-step mode).

Supply Voltage

- 24 up to 80 VDC

Usable Danaher Motion Motors

- 2-phase hybrid stepper or
- high-performance hybrid stepper that uses the patented Sigmax principle

The output current from the DSM9 must match the rated current for the motor winding, or be adjusted accordingly.

Features

The pulse-width modulated 4-phase **bipolar chopper output stage** controls the currents in the motor windings electronically, using a 20 kHz chopper frequency.

- high level of suppression of the back-e.m.f.
- with low ripple in the inverter current
- reduced heat dissipation
- low level of electrical interference

Short-circuit/earth short protection circuit
This switches off the output stage if the motor outputs are short-circuited or shorted to earth. The DSM9 must be switched off and then on again to clear the fault status.

Temperature monitoring
If the housing temperature exceeds a maximum permitted value, the power stage is switched off. The red LED is on.

MOSFET power transistors
These make it possible to use a chopper frequency around 20kHz, working close to the human hearing frequency limit and are therefore not audible.

Signal connections via optocouplers
The inputs for pulse frequency, direction and enable are electrically isolated from the supply voltage by optocouplers in the input circuitry. These measures increase the noise immunity of the signals to currents in the earthing/grounding conductors. The signal source for the pulse and direction signals does not require a ground reference on the DSM9 side.

Settings with DIL-switch S1

Motor current
Sets the phase current in the motor to 32 different values

Step size / Micro-steps
Defines the step resolution, i.e. the amount by which the motor rotates per step pulse. A full step for the Danaher Motion stepper motors produces a rotation of 1.8 angular degrees.
decimal
1/1, 1/2, 1/2,5, 1/5, 1/10, 1/25, 1/50, 1/125 of a full step, equivalent to 200, 400, 500, 1000, 2000, 5000, 10,000, 25,000 micro-steps/turn.
binary
1/2, 1/4, 1/5, 1/8, 1/16, 1/32, 1/64, 1/128 of a full step, equivalent to 400, 800, 1000, 1600, 3200, 6400, 12,800, 25,600 micro-steps/turn.
(See Chapter 4.1.1 “Step size” Page 30.)

Idle current reduction (ICR)
When the motor is idling (i.e. not stepping) the current in the winding can be reduced to 50 % of the preset value. This feature can be switched on or off. The current reduction becomes effective 0.1 sec after the last step pulse. Jumpers can also be used to set this delay to 0.05 or 1 second.

When the next step pulse arrives, the current returns to 100 % of the preset value

Configuration of the enable input with jumper J6
Inverts the sense of the enable signal.

- If the jumper J6 (pos. 5-6) is inserted, then the controller is **enabled** when current flows through the optocoupler.
- If the jumper is removed, then the controller is **inhibited** when current flows through the optocoupler.

Typical applications

Typical applications for the DSM9 controller are, for example:

- X-Y coordinate tables and slides
- packing equipment
- industrial robot engineering
- special-purpose machinery
- material feeders
- labeling machines

1.2 Other system components

Summary

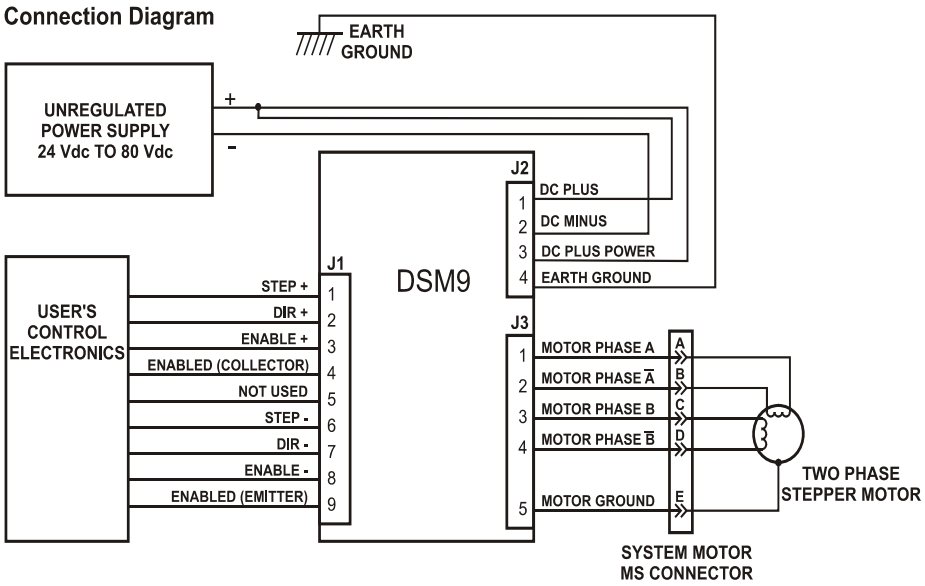
The other components that can be added to the DSM9 to form a complete system are:

- Pulse or indexer
- Uncontrolled power supply unit for the 24 - 80V_{DC} supply voltage
- phase Stepper motor

The installation notes for these components can be found in Chapter 2 “Installation of the DSM9 stepper motor controller”.

Block diagram

The following block diagram shows the basic connections for the drive in a typical system.



Your system probably could deviate from this diagram. Screens are not shown.

1.3 About this manual

This technical description contains information on connecting and setting up the DSM9 stepper motor controller, as well as notes on fault-finding and removal.

Please refer to the notes in the individual chapters and application note “Power Supply Unit” for planning the electrical installation, selecting/building a power supply unit, or installation and commissioning. This will help you to avoid the mistakes and problems.

1.4 Warranty

Danaher Motion provides a **one-year warranty** for the DSM9 drives with respect to material or production faults. However, this warranty does not cover equipment that has been modified by the customer, treated roughly, incorrectly handled or improperly used (e.g. incorrect wiring, wrong switch settings and the like).

2 Installation of the DSM9 stepper motor controller

In this chapter

This chapter describes the installation of the DSM9 stepper motor controller. It covers the following topics:

- Checking goods received
- Safety information
- Selection of additional system components
- Mechanical installation of the DSM9
- Electrical installation of the DSM9

2.1 Check on receipt

Check

As soon as you received the goods, check the equipment and the packaging for possible transport damage. Any visible damage must be noted on the waybill by the transport driver when the goods are accepted.
If you discover any hidden or obvious damage, make records of it and inform your shipping agent at once (by post: within 24 hours of delivery).

1. Remove the DSM9 from the transport box.
   Remove all packaging material from the equipment.
2. Check the contents against the delivery note.
   There is a label attached to the inside of the chassis that states the device type, serial number and date code.

Storing the equipment

After checking, store the equipment in a clean, dry place. The storage temperature must be within the range from –55 °C to +70 °C. Pack the equipment back into the original box, to prevent damage in storage.

2.2 Use as directed

- Stepper motor controllers DSM9 are components that are built into electrical plant or machines, and can only be operated as integral components of such plant or machines.
- The manufacturer of the machine must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.
- Stepper motor controllers DSM9 can be supplied from Dcvoltage up to 80V DC maximum.
- Hints for earthing the stepper motor controller must be followed.
- Supply voltage must never exceed 80V DC.
- If the stepper motor controllers are used in residential areas, in business/commercial areas, or in small industrial operations, then additional filter measures must be implemented by the user.
- The stepper motor controllers are exclusively intended for driving suitable stepper motors with closed-loop control of speed and/or position. The rated current of the motors must be at least as high as the adjusted current of the DSM9.
- The stepper motor controllers must only be operated with the defined ambient conditions. Ventilation or cooling may be necessary to keep the temperature within the cabinet below 50°C.
- Use only copper conductors for wiring. The conductor cross-sections can be derived from the standard EN 60204 (alternatively for AWG cross-sections: NEC Table 310-16, 60°C or 75°C column).
- The manufacturer of the machine is responsible for conformity of the complete system to European standards.

2.3 Safety rules

Your responsibility

As the project engineer or user of this device, you are responsible for the decision that the product really is suitable for the intended application. In no circumstances will Danaher Motion accept any responsibility or liability for indirect or consequential damage that may arise as a result of incorrect use of the product.

Read this manual completely to operate the DSM9 in a safe and effective manner.

The voltages inside the DSM9 are high enough to give a dangerous electric shock to any persons that come into contact with them.

Observe the following safety rules in order to avoid such shocks.

- **Never operate the stepper motor controller with a motor cover that is not earthed. Make sure that**
  - motor PE (motor cover) is connected to J3-5
  - mains PE (protective earth) is connected to J2-3
- **Only use the input and output terminals and connectors for connecting wires.**
- **Always disconnect the supply voltage before making or breaking any connections to the equipment.**
- **If the motor has been disconnected, be especially careful with the J3 terminals used for connecting the motor. If voltage is applied to the drive equipment while the motor is disconnected, then a very high voltage appears at these terminals.**
- **Switching off the Enable input to inhibit the drive does not count as safe disconnection in an emergency situation. For safe disconnection of the drive, always disconnect the supply voltage.**

2.4 Selection of additional system components

Selecting a pulse generator

Step pulse and direction signals must be applied to the DSM9.
Choose a pulse generator or an indexer that provides these signals as a minimum. A suitable indexer must be able to drive the input circuits as described in Chapter 3.1.3. Most applications that need speeds above 100 rpm require a pulse generator or indexer that is able to ramp up or down to the required pulse frequency.

Selecting a motor

The DSM9 controller is designed to drive a 2-phase hybrid stepper motor from the Danaher Motion product range. This can be either a standard hybrid stepper motor, or a high-performance hybrid stepper that uses the patented Sigmax principle. Most of the 2-phase stepper motors from other manufacturers will also be acceptable.

The motor current from the DSM9 must match the rated current for the motor winding, or be adjusted accordingly.

You can obtain characteristic torque/speed curves from your distributor on request. Contact you local Danaher Motion distributor for advice on dimensioning drives and selecting motors.

Selecting of the PSU

Operation of the DSM9 requires a power supply unit (PSU) with a single voltage output.
The logic circuits can be powered seperately (e.g. Logic: 24V, Power: 70V).

For multi-axis applications, install a separate cable from the PSU via a fuse to each DSM9. This is better than serial cabling of the supply voltage from one device to another.

The permissible supply voltage must be in the range 24 to 80 V DC (max). Obtaining full power from the DSM9 requires a maximum current capacity of about 6,4A. The power supply does not have to be a regulated PSU.

- **The supply voltage must never exceed 80V DC, not even very briefly. Ignoring this limit can damage the equipment.**
- **During braking, motors feed back energy into the PSU. This causes the supply voltage to rise.**
- **Important information on the PSU can be found in Chapter 3.1.2 . Read this section before choosing or building a power supply unit.**

2.5 Mechanical installation of the DSM9

Installation tips

- Align the device so that it is vertical, mount to back or large side.
- Mount the device on an even, solid surface, that is able to carry the weight of the device, about 0.5 kg.
- The installation site must be free from external shocks, vibration, or knocks.
- There must be at least 10 cm of free space above and below the device.
- The maximum chassis temperature (60 °C) and maximum ambient temperature (50 °C) for the device must not be exceeded.
- Use the two openings in the chassis to fix the DSM9 in place with M4 screws.

Rules for cooling

The temperature of the DSM9 chassis must be kept below 60 °C. Ignoring this limit can damage the equipment.
Check the surface temperature by direct measurement, using a temperature probe in a system that is in operation. The difference between the ambient temperature during these measurements and the worst-case (maximum) ambient temperature that can be expected must be added to the chassis temperature that was actually measured. The sum must be below 60°C.

Heat dissipation as a function of motor current

The heat generated by losses in the DSM9 depends on the motor current. The installation must be implemented in such a way that the maximum chassis temperature of 60 °C is not exceeded.

Mounting without Cooling plate or Heat sink

Keep free space of at least 100 mm above and below the device and 25mm beside.

	Ambient Temperatur	Max. motor current
Natural convection	25°C	3,1 A
	45°C	1,5 A
With ventilator	25°C	6,4 A
	45°C	3,1 A

Mounting on a cooling plate

Thickness and surface of the mounting plate in the switchgear cabinet (aluminium plate or heat sink) are sufficient to keep the chassis of the DSM9 controller below 60 °C.

- use a heat-conducting sheet or paste
- remove the paint from the mounting surface, to improve heat conduction

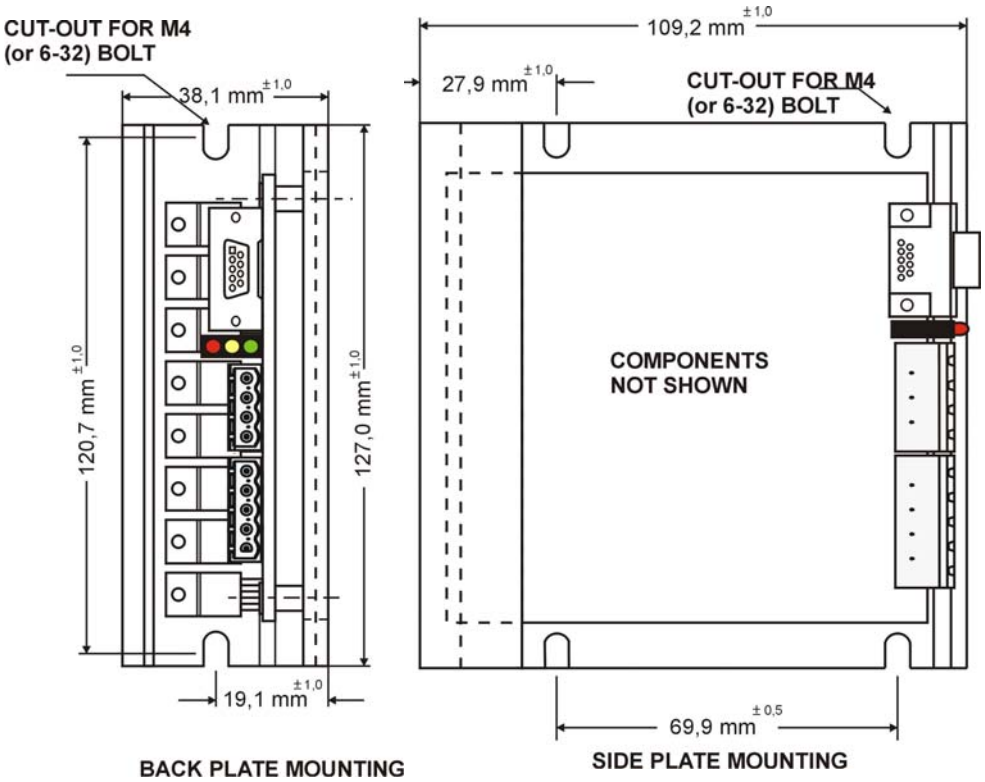
	Ambient Temperatur	Max. motor current
Natural convection	25°C	5 A
	45°C	2,5 A
With ventilator	45°C	5 A

Mounting with heat sink HS6410

The optional HS6410 heat sink can be mounted on the side of the DSM9
This unit can then be mounted by the back onto a mounting plate.
Keep free space of at least 100 mm above and below the device.

	Ambient Temperatur	Max. motor current
Natural convection	25°C	6.4 A
	45°C	3.1 A
With ventilator	45°C	6.4 A

Dimensions



3 Connections to the DSM9

3.1 Electrical installation of the DSM9

Introduction

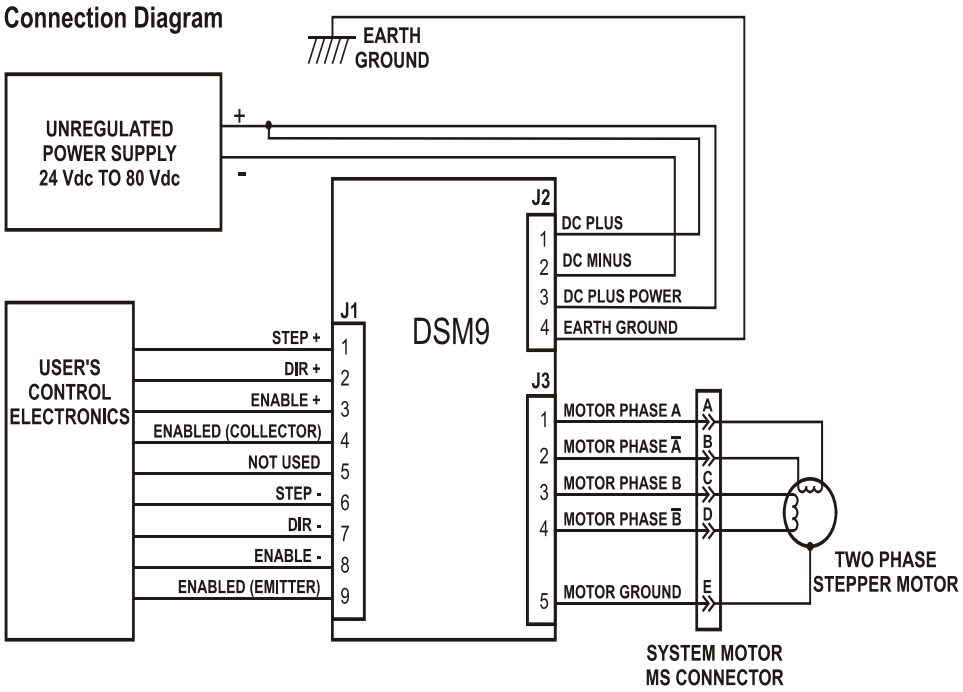
The following three input/output connectors are provided:

- J1 - Signal connector
- J2 - Supply voltage connector
- J3 - Motor connector

These inputs and outputs are described in the following section.

Block diagram

Shielding is not shown!



The cabling depends on the application

The conductor cross-sections and methods of connection described below, as well as the grounding and shielding measures, are in general use and are adequate for most applications.

Unusual applications, special standards and regulations, specific operating conditions and system configurations, may make it necessary to deviate from the situation given here.
Such requirements would then have priority over the information presented here.
It is therefore possible that you will have to connect up the drive in a different way to the one described.

Installation

- Use twisted and shielded cables for the signal and power cables, as described below. These precautionary measures reduced electrical interference.
- Install a well-earthed busbar close to the DSM9 stepper motor controller, to which you can make large-area connections for the shielding of the cables, using cable clamps.
- Shielding should continue right up to the DSM9.
- The length of cable between the earthing busbar and the DSM9 should not be more than 1 meter.
- The DSM9 chassis should also have a large-area conductive connection to the protective earth (PE). The paint on the contact area must be removed, to provide a good electrical connection and also good thermal conduction (use heat-conducting paste)

A number of manufacturers offer suitable components for earthing rails and cable clamps, such as Phoenix (SK14 terminals, NLS-Cu 3/10 rails, and the corresponding mounting stand-offs AB/SS-M) and Weidmüller (KLBÜ shielding terminals).

Risk of electric shock

See Chapter 2.3 for the safety rules that must be followed in order to reduce the risk of an electric shock.

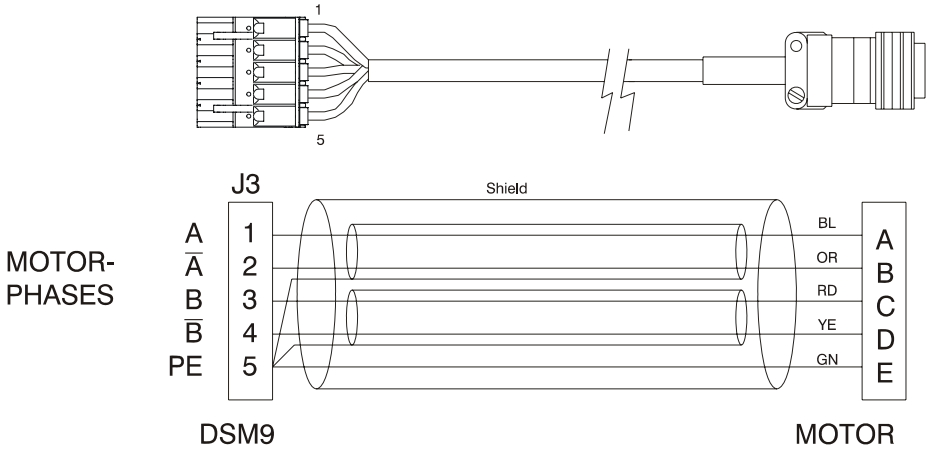
3.1.1 Connector J3: Motor connection

Introduction

The motor cable connects the controller, via J3, to the motor windings and housing. J3 is a plug-in terminal that enables easier installation and faster connections and disconnection of the connector.

Danaher Motion System Motors

If you use Danaher Motion System Motors (with MS round connectors) that are already fitted with the mating connectors, then connect them up as shown below.



All cores are 1.0 or 1.5 mm²

Assembling a motor cable

Follow the instruction given below for the connections to the connector J3. Different sets of instructions are provided in this section for the connections to the different types of motor. For 8-wire motors, the windings for a particular phase are normally connected in parallel. If you connect the motor phase windings in series, then the rated current for the motors is halved, and the maximum speed is also reduced.

J3 connections

OUTPUT	PIN	EXPLANATION
Motor phase A	J3-1	Excitation of motor phase A (twisted pair)
Motor phase $\overline{A}$	J3-2	
Motor phase B	J3-3	Excitation of motor phase B (twisted pair)
Motor phase $\overline{B}$	J3-4	
Protective earth	J3-5	Connection to the motor housing

Connect the housing of the motor (via the protective conductor) to pin 5 of J3. Connect the inner cable shielding to pin 5 of J3.

IMPORTANT: Make a wide-area contact of the (outer) screen to the earthing busbar mentioned previously.

Mating connector

The motor connector J3 on the DSM9 is a plug-in terminal connector from Phoenix, type FKCT 2,5-5-ST.

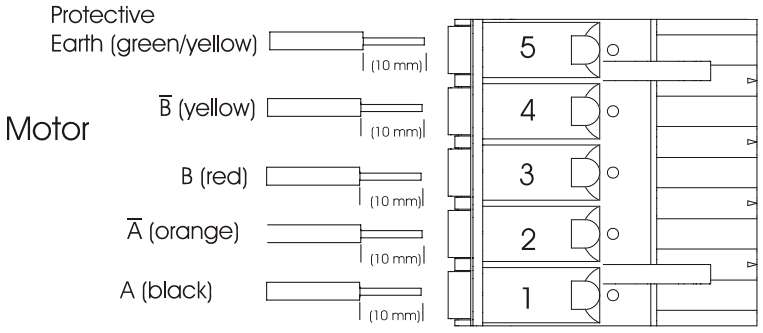
Specification for the cable

Observe the voltage drop with long cables.
It is better to use a more generous dimension for the conductor cross-section than the minimum required for the actual current, especially for long motor cables, as this reduces the voltage drop in the cable

Use a shielded cable for the motor cable with
- lead cross section 1.0 mm² up to 1.5 mm²
- 4 leads (twisted pairs) plus protective lead

If the motor cable needs to be longer than 20 meters, please consult your distributor. With long cables, it is advantageous if the twisted pairs of the phase leads have individual shielding for each pair.

J3 assignments



The colors given in this diagram are those of the Danaher Motion color code for stepper motors.

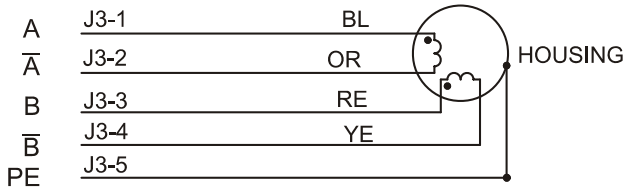
Procedure

1. Strip off 10 mm of the stranded leads.
2. Connect the leads to the plug-in terminal strip as shown in the diagram.

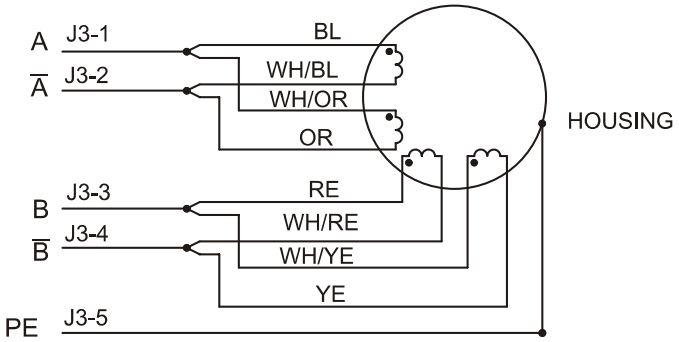
Do not solder the ends of the stranded leads. Cold solder flows under pressure, and therefore leads to a loose connection after some time.

Connection for motors with flying leads

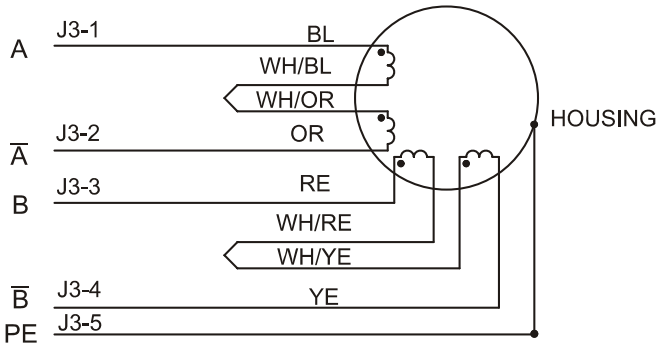
The 3 diagrams show how a Danaher Motion motor with flying leads can be connected to the J3 connector on the DSM9 controller.



4-LEAD MOTOR



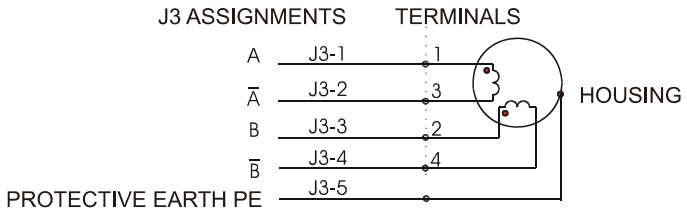
8-LEAD MOTOR PARALLEL CONNECTION



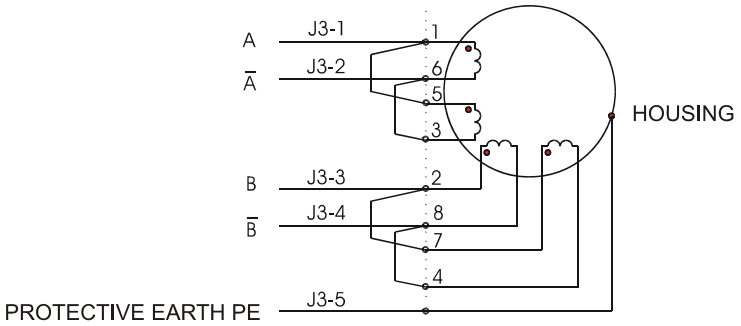
8-LEAD MOTOR SERIAL CONNECTION

Connection for motors with a terminal box

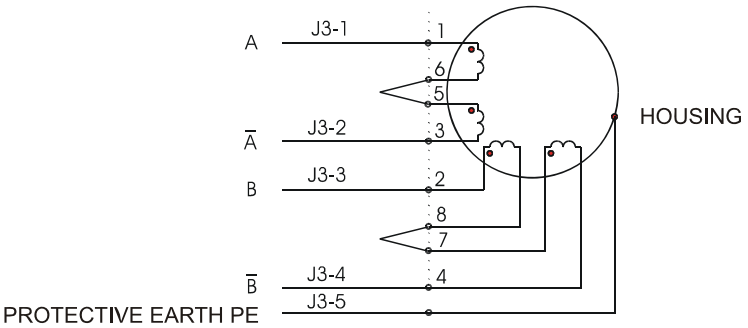
The diagram below shows the connections that are required between J3 and Danaher Motion stepper motors with terminal boxes on the back end-shield.



4-WIRE MOTOR



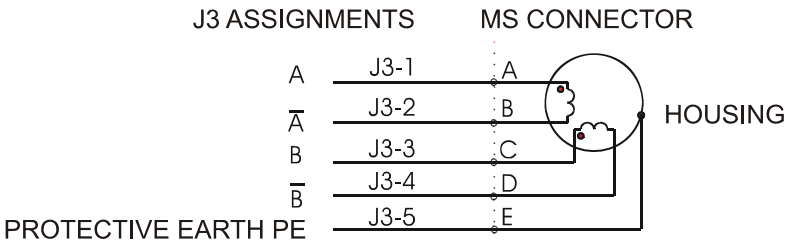
8-WIRE MOTOR, PARALLEL WIRING



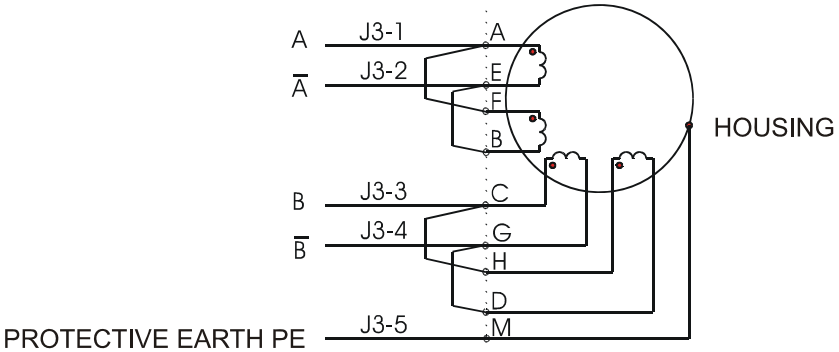
8-WIRE MOTOR, SERIES WIRING

Connection for System Motors with MS connectors

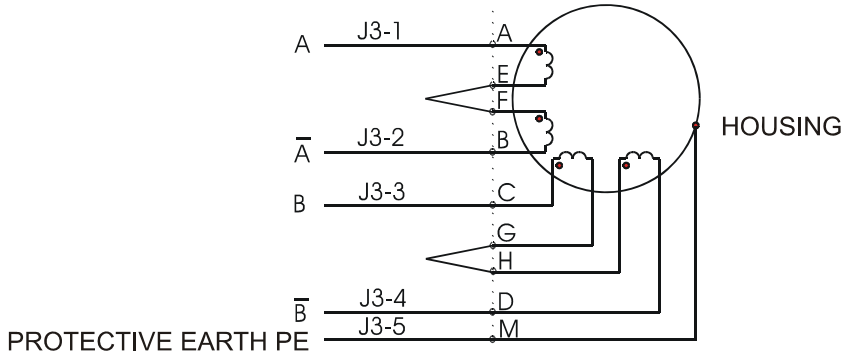
The diagram below shows the connections required from the connector J3 on the DSM9 to Danaher Motion stepper motors with MS round connectors.



4-WIRE MOTOR



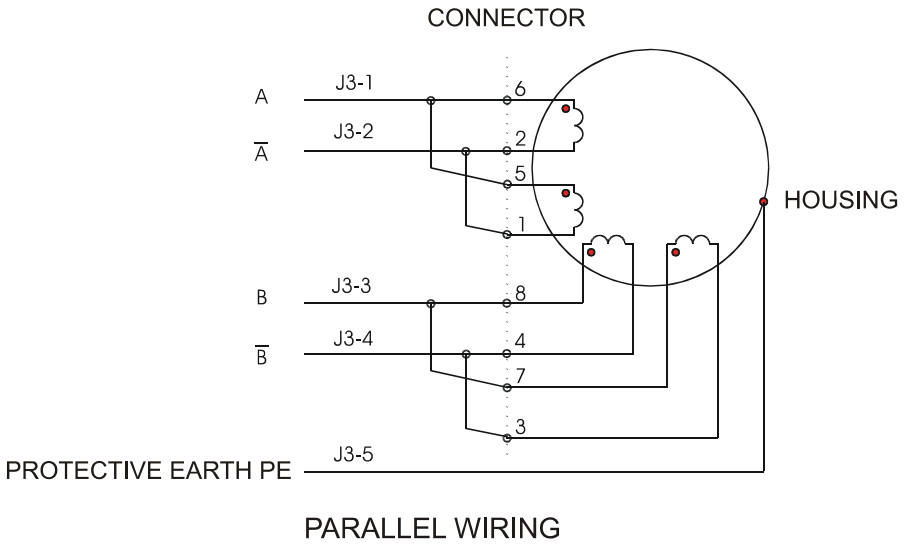
8-WIRE MOTOR, PARALLEL WIRING



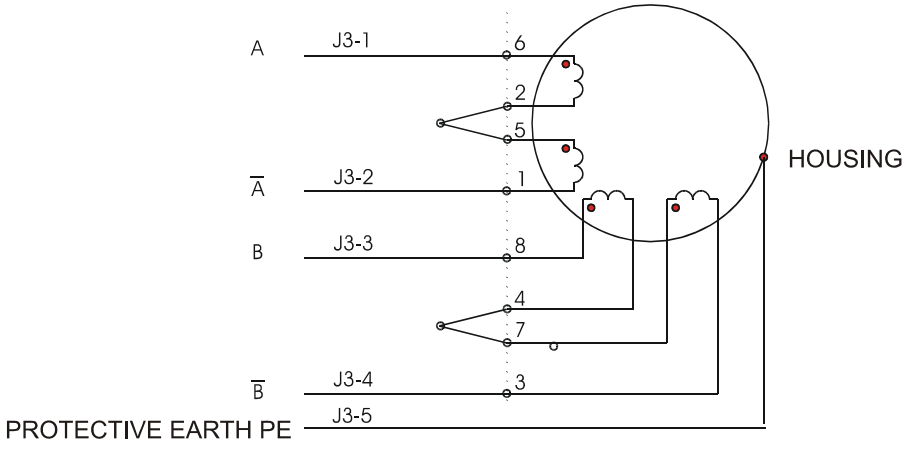
8-WIRE MOTOR, SERIES WIRING

Connection for Power-Max motors

The diagram below shows the connections required between the DSM9 and Pacific Scientific PowerMax motors. Power-Max motors have an 8-pole connector.



PARALLEL WIRING



SERIES WIRING

3.1.2 Connector J2: Supply voltage

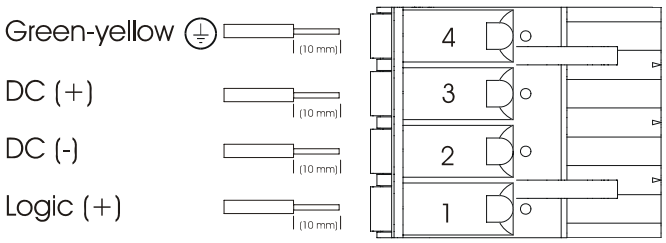
Introduction

The supply voltage from the PSU is fed to the DSM9 via J2. See our application note for the power supply requirements.

Connector J2:

Input	Pin	Explanation
DC + Logic	J2-1	+24 up to max. +80V DC, max. 6,4A Logic can be supplied seperately with a lower voltage. The negative connection of the supply must be joined externally to PE (protective earth).
DC –	J2-2	
DC + Power	J2-3	
⏚	J2-4	Protective earth connection for the DSM9 chassis, internally joined to the PE terminal of the motor connector J3-5.

Diagram:
Connector J2:



Procedure

1. Strip off 10 mm of the stranded leads.
2. Connect the leads to the plug-in terminal connector as shown in the diagram.

Do not solder the ends of the stranded cores. Cold solder flows under pressure, and therefore leads to a loose connection after some time.

Voltage supply

The block diagram on the next page shows the connections between the power supply unit and the device. In this example, a simple unregulated power supply is used. The logic supply ist not shown.

- The capacitor (storage capacitor type) between DC+ and DC– must be wired not more than 1m away from the DSM9.
- Install a slow-blow 10A fuse (not a circuit-breaker) between the power supply and the storage capacitor.
- If several DSM9 controllers are in the same installation, install a separate fuse and cable connection from the PSU to the storage capacitor of each DSM9.

Cable requirements

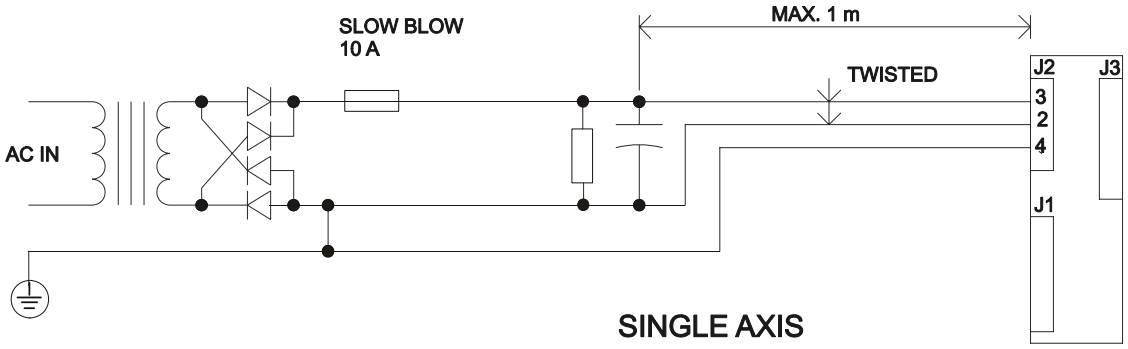
Use shielded cable to connect the PSU to the fuse and capacitor. Ground the shield with a large-area earthing clamp.

- The connection between the capacitor and the DSM9 must have a twisted pair for DC+ and DC–.
- The leads must be twisted with 1 to 1½ turns per centimeter.
- The lead for the protective earth should not be twisted together with this pair. The connection must not be longer than 1 meter.
- The 3 leads must be covered by a shielding braid.
- Use cables with a 1.5 mm² cross-section for the supply voltage.

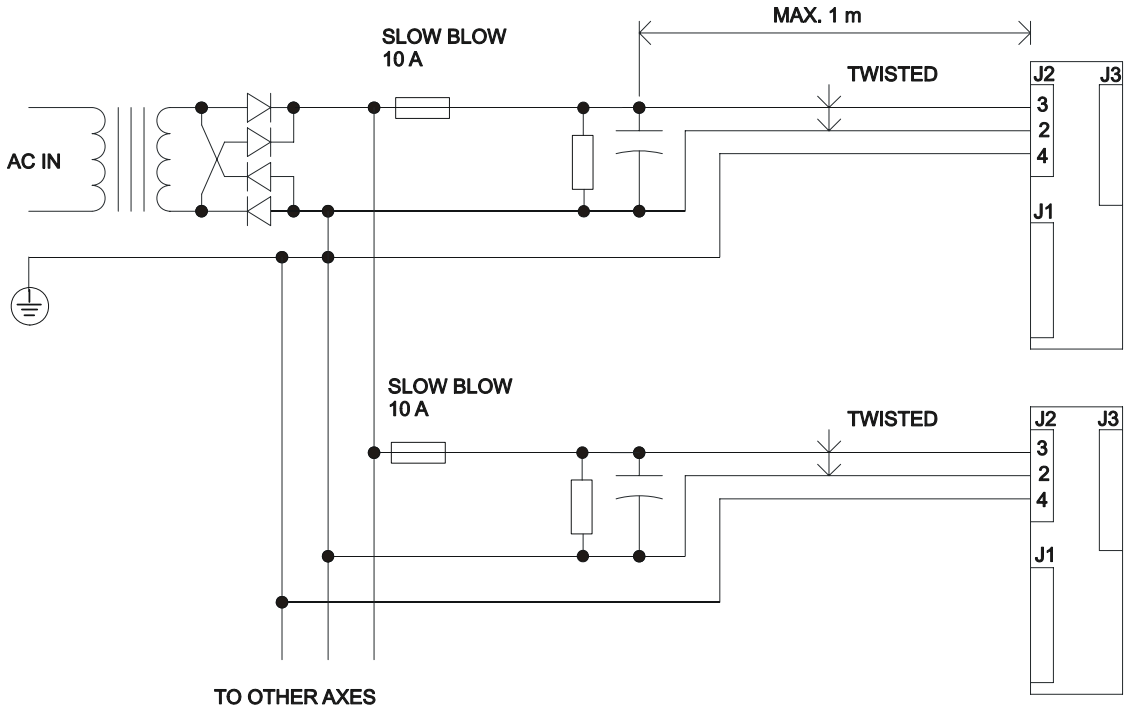
The supply voltage must never go above 75 V, not even very briefly.
Voltage spikes in the supply voltage are the most frequent cause of equipment failure.
The PWM-modulated chopper controller does not draw a constant current, but a pulsed current. That is why it is important that the inductance of the cable between the external capacitor and the DSM9 is kept down. To achieve this, the connecting cable must not be longer than 1 meter, and must be a twisted and shielded pair.

Wiring diagram

Shielding is not shown.



SINGLE AXIS



MULTI-AXIS

3.1.3 Connector J1: Signal connections

Introduction

The step pulse and direction signals from an external indexer or pulse generator, together with the enable signal, are wired up to the signal connector J1. The *Enabled* output of the DSM9 can also be accessed here. It indicates that the motor windings are being driven.

All inputs and outputs are isolated via optocouplers.

Assignment

Input / output	Pin	Explanation
STEP+ (pulse +)	J1-1	Step pulse input to create a rotation of the motor. See the following diagram for information on the circuitry and timing.
DIR + (rotation +)	J1-2	Rot. direction input to select direction of rotation of the motor. With the standard motor wiring, the motor rotates clockwise when the optocoupler is *not* activated, i.e. when no current flows from DIR+ to DIR–. The polarity of the DIR (direction of rotation) input can be reversed by swapping the core pair to one motor phase (not both) on the motor connector (i.e. A swapped with $\overline{A}$). See the following diagram for information on the circuitry and timing.
ENABLE +	J1-3	This input is used to enable or inhibit the motor current. If the jumper J6 (pos. 5-6) is removed (factory default setting), then the output stage is enabled when no current flows through the optocoupler. The output stage is inhibited if current is flowing through the optocoupler. If jumper J6, pos. 5-6, is inserted, then the function of this input is reversed. See the following diagram for circuit information. There is a delay of roughly 500 µsec between applying the drive enable to the input and the activation of the power output stage.
Enabled collector (*Enabled* output) – collector output –	J1-4	Collector output. The transistor is switched on as soon as the output stage of the DSM9 is enabled. See the following diagram for information on the circuitry and timing.
	J1-5	unused
STEP– (pulse –)	J1-6	Step pulse input to create a rotation of the motor.
DIR – (rotation –)	J1-7	Rot. direction input to select direction of rotation of the motor. Description see DIR+.
ENABLE –	J1-8	This input is used to enable or inhibit the motor current. Description see ENABLE+.
Enabled emitter (*Enabled* output) – emitter connection –	J1-9	Emitter connection. The transistor is switched on as soon as the output stage of teh DSM9 is enabled. See the following diagram for information on the circuitry and timing.

Mating connector

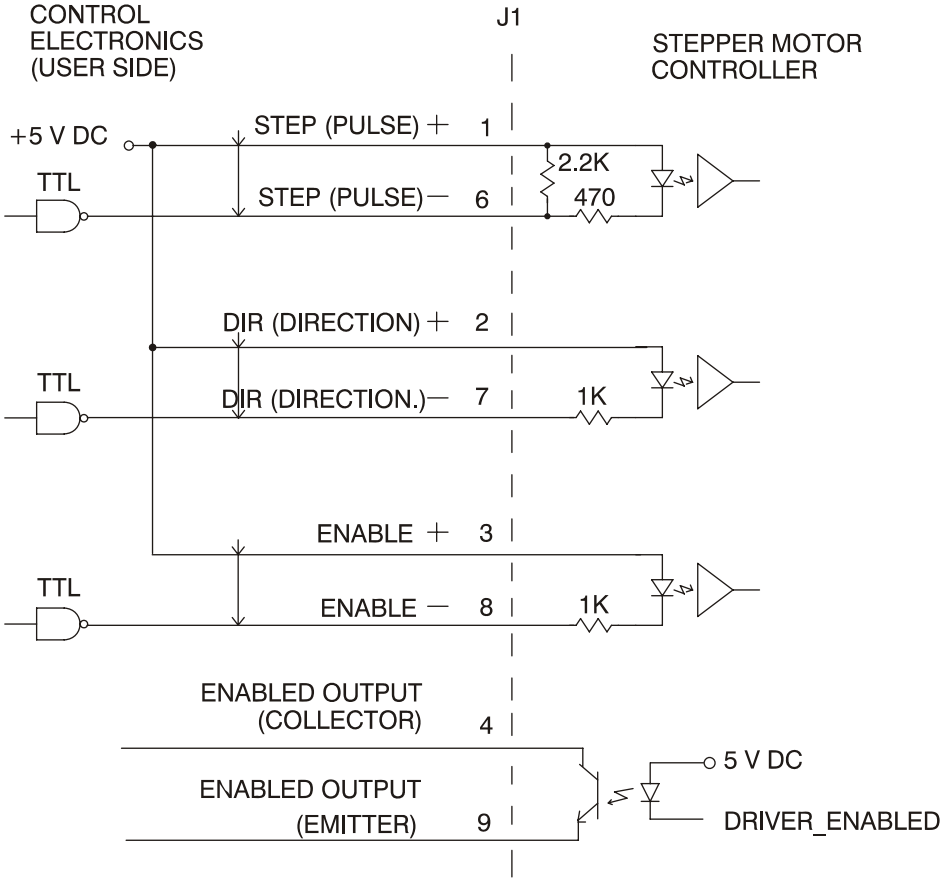
The signal connector J1 is a 9-pole Sub-D socket. The mating connector can be obtained from ITT, among others.
ITT ordering details:
Sub-D plug DE-9P with hood Sub-D DE110963 and strain relief D20419.

Typical wiring

The circuit diagrams on the following pages show typical implementations of the wiring between an external indexer and DSM9 controllers. The TTL gates should have differential driver outputs, and be able to sink at least 10.0 mA at a max. output ON-state voltage of 0.4V.

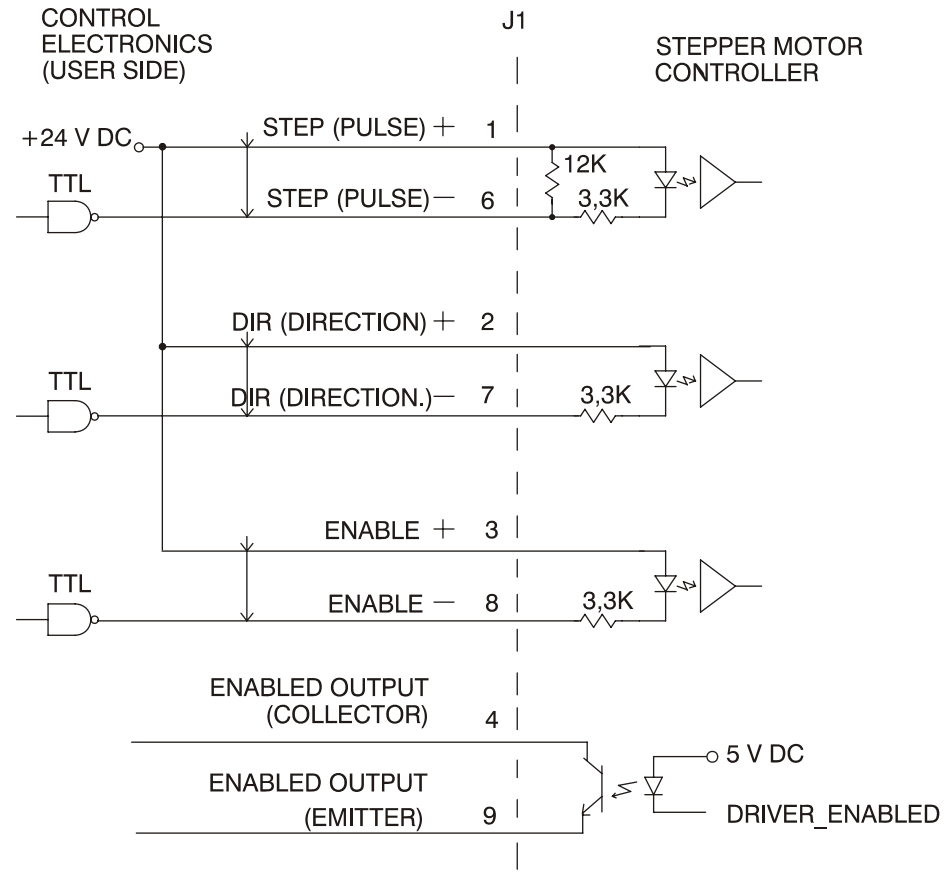
Circuitry and timing

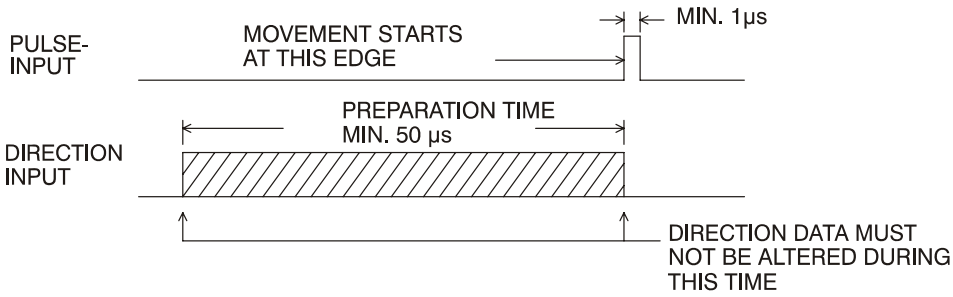
5VTTL DSM9-SD-03



Circuitry and timing

24V/SPS DSM9-SD-01





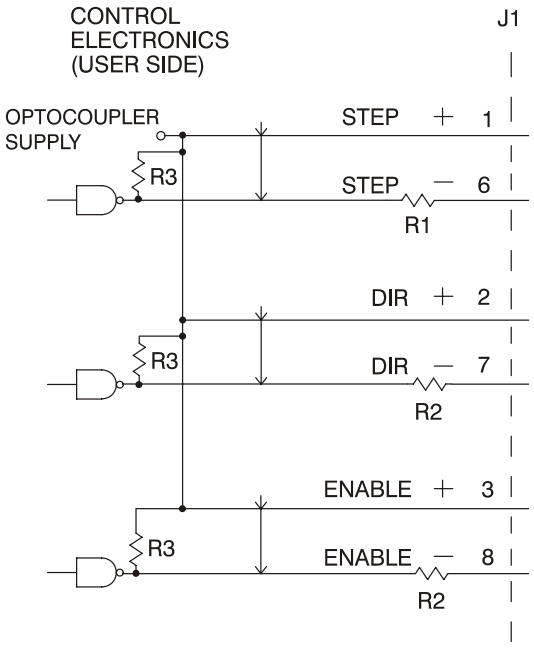
Signals with higher voltage

For the signals an input of up to 30V is permissible. However, a resistor must be wired in series with the optocoupler diode, as shown below.

If your pulse generator or indexer produces output signals with a level above 5V, then you can find the value for the series resistance for various voltages in the following table.

If the indexer or pulse generator does not have drivers with a differential output, but open-collector transistor outputs, then you should include pull-up resistors (R3) as shown. A typical value for R3 would be 2k7.

Optocoupler series resistance	**R1 (ohms)**	**R2 (ohms)**
+ 12 V DC	1 k	1k5
+ 15 V DC	1k5	2k2
+ 24 V DC	2k4	4k7
+ 30 V DC	3k3	6k8



4 Commissioning the DSM9 drive

In this chapter

This chapter explains how the DSM9 drive is commissioned:

- Using the switch S1 and jumper J6 to set up functions.
- Testing the system

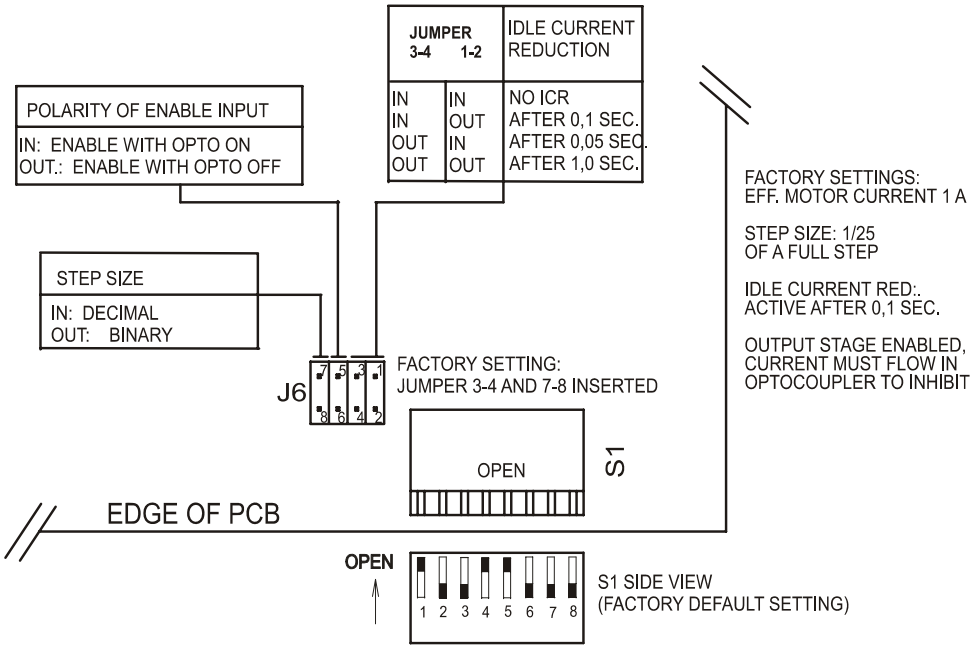
4.1 Settings for switch S1 and jumper J6

Introduction

The DIL-switch S1 and jumper J6 are used to set:

- the step size
- the motor current
- idle current reduction (ICR)
- the effective polarity of the enable input

Settings for switch S1 and jumpers



POSITION S1			STEP SIZE	
1	2	3	DEZ-JUMPER IN	DEC-JUMPER OUT
CLOSED	CLOSED	CLOSED	1/1	1/2
CLOSED	CLOSED	OPEN	1/2	1/4
CLOSED	OPEN	CLOSED	1/2,5	1/5
CLOSED	OPEN	OPEN	1/5	1/8
OPEN	CLOSED	CLOSED	1/10	1/16
OPEN	CLOSED	OPEN	1/25	1/32
OPEN	OPEN	CLOSED	1/50	1/64
OPEN	OPEN	OPEN	1/125	1/128

POSITION S1					EFF. MOTOR CURRENT IN AMPERE
4	5	6	7	8	
CLOSED	CLOSED	CLOSED	CLOSED	CLOSED	6,4
CLOSED	CLOSED	CLOSED	CLOSED	OPEN	6,0
CLOSED	CLOSED	CLOSED	OPEN	CLOSED	5,5
CLOSED	CLOSED	CLOSED	OPEN	OPEN	5,0
CLOSED	CLOSED	OPEN	CLOSED	CLOSED	4,7
CLOSED	CLOSED	OPEN	CLOSED	OPEN	4,4
CLOSED	CLOSED	OPEN	OPEN	CLOSED	4,1
CLOSED	CLOSED	OPEN	OPEN	OPEN	3,8
CLOSED	OPEN	CLOSED	CLOSED	CLOSED	3,5
CLOSED	OPEN	CLOSED	CLOSED	OPEN	3,1
CLOSED	OPEN	CLOSED	OPEN	CLOSED	2,9
CLOSED	OPEN	CLOSED	OPEN	OPEN	2,7
CLOSED	OPEN	OPEN	CLOSED	CLOSED	2,5
CLOSED	OPEN	OPEN	CLOSED	OPEN	2,3
CLOSED	OPEN	OPEN	OPEN	CLOSED	2,1
CLOSED	OPEN	OPEN	OPEN	OPEN	1,9
OPEN	CLOSED	CLOSED	CLOSED	CLOSED	1,8
OPEN	CLOSED	CLOSED	CLOSED	OPEN	1,7
OPEN	CLOSED	CLOSED	OPEN	CLOSED	1,6
OPEN	CLOSED	CLOSED	OPEN	OPEN	1,5
OPEN	CLOSED	OPEN	CLOSED	CLOSED	1,4
OPEN	CLOSED	OPEN	CLOSED	OPEN	1,3
OPEN	CLOSED	OPEN	OPEN	CLOSED	1,2
OPEN	CLOSED	OPEN	OPEN	OPEN	1,1
OPEN	OPEN	CLOSED	CLOSED	CLOSED	1,0
OPEN	OPEN	CLOSED	CLOSED	OPEN	0,90
OPEN	OPEN	CLOSED	OPEN	CLOSED	0,80
OPEN	OPEN	CLOSED	OPEN	OPEN	0,68
OPEN	OPEN	OPEN	CLOSED	CLOSED	0,63
OPEN	OPEN	OPEN	CLOSED	OPEN	0,60
OPEN	OPEN	OPEN	OPEN	CLOSED	0,44
OPEN	OPEN	OPEN	OPEN	OPEN	0,40

4.1.1 Step size

Definition

The step size defines the amount by which the motor rotates for each step pulse on the input. In the following table, this rotation is given as a fraction of a full step.

As a result of their design, all Danaher Motion and all 1.8° stepper motors have these features:
One full step rotates the motor shaft by 1.8°.
For such motors, the value is given in steps per revolution.

15 different step sizes are available, by combining the settings of jumper block J6, position 7-8, and the DIL-switch S1, positions 1–3, as shown below.

Decimal step sizes		Binary step sizes	
fraction of full step	**=> steps/rev**	**fraction of full step**	**=> steps/rev**
1/1 full step	200	1/2 half step	400
1/2 half step	400	1/4	800
1/2,5	500	1/5	1000
1/5	1.000	1/8	1.600
1/10	2.000	1/16	3.200
1/25	5.000	1/32	6.400
1/50	10.000	1/64	12.800
1/125	25.000	1/128	25.600

Advantages

If you select a micro-step of 1/4 or smaller, then you get:

- higher resolution
- smoother operation at low speed
- the option of operating the drive at low speeds in regions that would otherwise suffer from resonance.

Requirement

Your indexer or pulse generator must be able to produce the considerably higher pulse rates that are required.

4.1.2 Idle current reduction (ICR)

Definition

The idle current reduction (ICR) reduces the motor phase current when the motor is at idling, i.e. just holding its position. The motor phase current is reduced as soon as the controller has not received any step signals for a preset length of time. This time can be 0.05 sec, 0.1 sec, or 1 second. A long delay makes sense for loads with an overshoot. The current that flows through both halves of the motor winding is reduced by 50 %. The reduction always refers to the motor current as set.
The ICR function can be switched off, so that the idle current is the same as the current for a moving motor. This is unfavorable, because of the heat that is produced.

Jumper J6, pos. 3-4	position 1-2	Idle current reduction
inserted	inserted	Function switched off
inserted	removed	active after 0.1 sec[1)]
removed	inserted	active after 0.05 sec
removed	removed	active after 1.0 sec

1) Factory setting

If the ICR function is switched on, then both the motor holding torque and the motor stiffness are reduced by 50 % when the motor is idling/holding.

Advantages

The idle current reduction function reduces heating of the motor and drive when the motor is idling and the output stage is enabled.

4.1.3 Setting the motor current

The motor current must be set by the DIL-switch S1, positions 4 to 8. The current that is set must correspond to the motor current rating.
If you use an 8-wire motor in a series connection, please note that the halved motor current in a parallel-connected motor would have the same heating effect. The inductance of a series connection of the windings is four times larger.

A table with the switch settings for various values of current can be found in the diagram *Settings for switch S1 and jumpers* on page 29.

- **The heat loss in the DSM9 controller increases with the output current, so that a higher motor current will require better cooling.**
- **Relevant information on cooling for the DSM9 can be found in Chapter 2.5 – Mechanical installation of the DSM9 –**

4.1.4 Configuration of the enable input

The polarity of the enable input action can be reversed by jumper J6, position 5-6.

- If the jumper is inserted, an Enable signal enables the DSM9
- If the jumper is removed, an Enable signal inhibits the DSM9 (factory setting).

4.2 Testing the system

Background

The test steps described below are used to check that there is no hidden transport damage to the DSM9 controller, and it has been properly installed.

Procedure

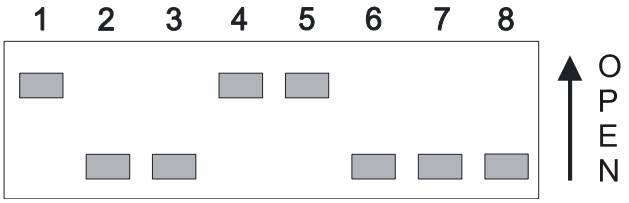
After the DSM9 has been installed, as described in Chapter 2, check your system as follows.

Faults may cause the motor to move unexpectedly.
For this reason:

- **When switching on for the first time, the motor shaft must be free, i.e. no load coupled to it.**
- **Fix the motor in such a way that it cannot fall over or cause any damage if it makes jolting movements.**
  - **Disconnect the supply voltage if any unexpected movements occur.**

Check connections

1) Check that the mounting and cooling of the equipment is correct, and check all cable connections, earthing and shielding.
2) *With the equipment switched off*, check that the DIL-switch S1, positions 1 to 8, are all set properly.
   The factory setting is shown below.



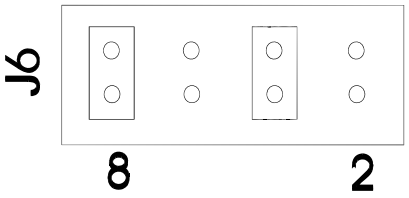
Interpretation of the factory setting:

- Step size: 1/25 of a full steps
- motor current is $1A_{eff}$.

If the rated motor current is not $1A_{eff}$, set the positions 4 to 8 accordingly.

Before continuing, check that no voltage is applied to the system.

3. Check that the jumper block J6 is set correctly. The factory setting is shown here.



Interpretation of the factory setting:

- Idle current reduction is active (with 0.1 sec delay)
- DSM9 is enabled when the enable input is unused
- Decimal step sizes are selected

4. Switch on the supply voltage.

Signal test

1. Test whether the motor has a holding torque, by trying to turn the motor shaft by hand. A current-carrying motor cannot be turned by hand, or only with great difficulty.
2. Apply step pulses, and see if the motor rotates.
3. Reverse the polarity of the direction signal (DIR) and apply step pulses to the motor. The motor must now rotate in the other direction.

Help, if required

If you need further support for your application, please contact your distributor.

5 Maintenance / Fault-finding

In this chapter This chapter describes maintenance and fault-finding for the DSM9 stepper motor controller.

5.1 Cleaning the DSM9 controller

Procedure Clean off surface dust and dirt from the device, by using clean, dry compressed air, at a low pressure.

5.2 Status LEDs

Green LED When the controller is enabled (motor is carrying current), the green LED lights up on the front panel of the device, and the DSM9 is ready for operation.

Yellow LED The yellow LED shows that step pulse signals are being received by the controller.

Red LED This shows that the fault detection (see below) has been triggered.

5.3 Fault-finding in a DSM9 drive

Introduction

The DSM9 controller has an *Enabled* transistor output that is electrically isolated, via an optocoupler.

- It is conducting if the drive is enabled, i.e. the motor is carrying current.
- It is non-conducting if the controller has been inhibited by the appropriate signal on the enable input, or if it has been de-activated for its own protection, because the internal protection circuit has detected one of the following faults:
  - o current overload of the output (short-circuit between two motor phases, or between a phase and earth)
  - o overheating

If one of the above protection circuits has been triggered, then the fault condition is immediately indicated by the red status LED on the front panel.

Use the following fault-finding table and the *Enable* output for diagnosis, as shown in the list. These two tools make it possible to solve most problems. If it is still not possible to operate the controller after this, please contact your Danaher Motion distributor.

If you come to the conclusion that the DSM9 controller is faulty, do NOT just replace it by another and then switch on again.

Instead, check:

- **the PSU dimensioning**
  You can find important tips about this in Appendix B, towards the end of this manual.
- **the wiring of the supply voltage**
  You can find important tips about this in Chapter 3.1.2 - Connector J2 Supply Voltage (on page 22)
  whether the chassis temperature was kept below 60 °C
  Important notes on thermal dimensioning can be found in Chapter 2.5 – Mechanical installation of the DSM9 – on page 12.

Supply voltage faults are the most frequent cause of controller failures.

Fault-finding table

SYMPTOMS	CORRECTIVE MEASURES
Motor has no (holding) torque and: green LED is off Red LED is on	State: an internal protection circuit has been triggered and has removed the enable. Switch off the supply voltage, detach the motor cable from connector J3, and switch the supply on again. If the *Enabled* output is now LOW, disconnect the motor at the motor end of the cable. Check the motor cable for core break, and for short circuits between the cores, or between the cores and the shielding. Check that J3 is correctly wired up. Check the detached motor for continuity of the individual phases, and for short circuits between the phases, or between the phases and the motor housing. Reconnect the motor, in accordance with the appropriate circuit diagram, as shown in Chapter 3.1.1 from page 15 onwards.
Motor has no torque, and the green LED is on Red LED is off	State: Controller is enabled, but the motor current is too low, or there is no motor current at all. Check that the DIL-switch S1, positions 4 to 8 (current setting), are all set properly. Check, as described above, that the motor cable is correctly wired up and properly plugged in to the drive.
Motor has a holding torque, but does not rotate Green LED is on Yellow LED is off	State: No step pulses are being detected at the step pulse input. Test the pulse input, for instance by applying a 4.5 V battery (with the right polarity). Unless an extremely small step size was selected, repeated on/off contacting of the battery must produce a visible movement of the motor shaft. Make sure that the step pulse input is wired up correctly, and the pulse source fulfills the electrical and timing/frequency requirements.
Motor rotates in the wrong direction	State: You need to reverse the sense/polarity of the direction input. Switch off the supply voltage. Swap the connections to one motor phase (not both) on J3. This will reverse the default direction of rotation.
Motor does not respond to the direction input	Test the direction input, for instance by applying a 4.5 V battery (with the right polarity). Make sure that the direction input is wired up correctly, and the signal fulfills the electrical and timing requirements.

Fault-finding table, continued

SYMPTOMS	CORRECTIVE MEASURES
Motor does not reach the expected position	Check whether the step size that has been set for the DSM9 controller matches the step size parameter setting for the indexer. Check whether the motor stops or loses steps because it is overloaded (required load or acceleration torque is too high) or because it is working in a resonance region. The noise made in operation is often a clue to such effects. 1. Check the drive dimensioning once more. Please note that the torque curve of a stepper motor depends on - the DC-bus voltage used for the controller (in the case of the DSM9, this is the supply voltage) - (if it is an 8-wire motor) whether the motor phases have a series or parallel connection. 2. Use a smaller step size, to avoid resonance problems at low speed (below about 120 rpm) 3. To avoid small step errors that accumulate when the drive moves backwards and forwards, make a special check whether the indexer maintains the necessary waiting time of at least 50 µsec for the direction signal, before it produces the first step pulse for a new movement. 4. Check that the signals at the step pulse and direction inputs fulfill all the specified electrical and timing requirements, and are not being falsified by interference.

Returning items for repair or exchange

If you come to the conclusion that the DSM9 controller and/or the stepper motor is faulty, then proceed as follows:

If you are the customer of a machinery manufacturer in whose machine Danaher Motion products are being used, then first contact the machinery manufacturer, and not the nearest Danaher Motion distributor. Machinery manufacturers often make small alterations, especially to motors, which the distributor does not know about, so that replacement equipment or motors from a distributor are no longer compatible, in spite of having the same type number.

If you acquired the product directly from a distributor, then please contact precisely this particular distributor. He will know the fastest way for repairs and exchange.

6 Technical data

6.1 Electrical data

Supply voltage 24 - 80V DC, 6.4 A

Output currents from the controller (motor-phase currents)

With DIL switches selectable valuas [A]	
0.4	**1.9**
0.44	**2.1**
0.6	**2.3**
0.63	**2.5**
0.68	**2.7**
0.8	**2.9**
0.9	**3.1**
1	**3.5**
1.1	**3.8**
1.2	**4.1**
1.3	**4.4**
1.4	**4.7**
1.5	**5**
1.6	**5.5**
1.7	**6**
1.8	**6.4**

Type of control bipolar 2-phase chopper control

Chopper frequency nominal 20 kHz

Step size

Can be set by switches	steps/rev (for 1.8° stepper motor)
1/1 **(1/2)**	200 **(400)**
1/2 **(1/4)**	400 **(800)**
1/2,5 **(1/5)**	500 **(1,000)**
1/5 **(1/8)**	1,000 **(1,600)**
1/10 **(1/16)**	2,000 **(3,200)**
1/25 **(1/32)**	5,000 **(6,400)**
1/50 **(1/64)**	10,000 **(12,800)**
1/125 **(1/128)**	25,000 **(25,600)**

Signal inputs

Signal inputs are isolated via optocouplers

Input	min. current to switch the optocoupler	max. current through the optocoupler	max. reverse voltage
J1-1, J1-6 step pulse	5.5 mA	10 mA	5 V
J1-2, J1-7 direction	3.0 mA	4.5 mA	5 V
J1-3, J1-8 enable	3.0 mA	4.5 mA	5 V

Features of the signal output

(See diagram in Chapter 3.1.3)

J1-4, J1-9
Enabled output

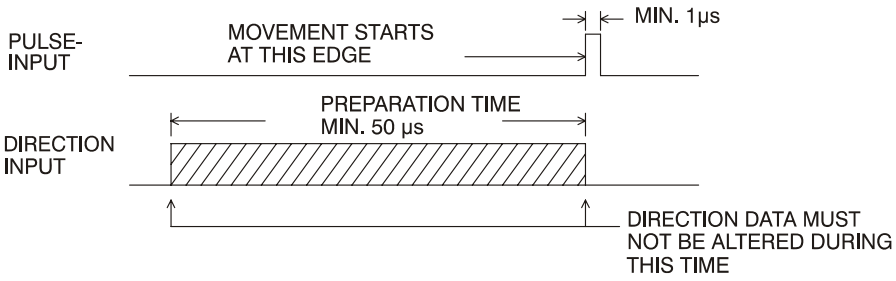
Optocoupler with an *npn* transistor in the output, open collector and open emitter
Maximum voltage drop in the ON (=LOW) state: 0.5 V, at 2 mA load current.

Maximum pulse frequency on the pulse input

500 kHz

Preparation time for direction input

The following diagram shows the timing relationships that are required between the step pulse and the direction input:



Delay between pulse and motor step

The delay for all step pulse rates is less than 100µs.

6.2 Ambient conditions

Operating temperature	The permissible ambient temperature is 0 °C to 50 °C, with or without a housing, provided that the chassis is properly mounted and cooled, so that the maximum permissible chassis temperature of 60 °C is not exceeded. Details on thermal dimensioning can be found in Chapter 2.5 .
Storage temperature	–55 °C to +70 °C
Maximum chassis temperature	60 °C **Note:** *Mount the DSM9 chassis (using the back or side panel) on a cooling plate or a heat sink, to ensure the best possible heat transfer. Use a heat-conducting sheet or paste between the DSM9 and the mounting plate or heat sink. The temperature of the DSM9 chassis must be kept below 60 °C in all circumstances. A fan can be installed to ensure this. If ICR is used, then the waste heat that is generated will be reduced.*
Humidity	10 to 90 %, no condensation permitted
Convection cooling	(These details apply if the DSM9 is not mounted on a cooling plate.)
With optional heat sink HS6410	Full motor current (6.4A) at +25 °C ambient temperature max. motor current 3.1 A at +45 °C ambient temperature
Without heat sink	max. motor current 3,1 A at +25 °C ambient temperature max. motor current 1.5 A at +45 °C ambient temperature

6.3 Mechanical data

Dimensions	see Chapter 2.5
Weight	approx. 0.5 kg

Connectors and mating connectors

Supply voltage	Phoenix Contact FKCT 2,5/4-ST RM5
Signal	9-pole Sub-D socket. Suitable mating connector: ITT Sub-D DE-9P with hood ITT Sub-D DE110963 and strain relief D20419
Motor	Phoenix Contact FKCT 2,5/5-ST RM5

Appendix A - Ordering details

Background

This appendix provides the type codes and ordering numbers for the DSM9 controller and accessories.

For the DSM9:

Designation	Ordering number	Comment
Stepper motor controller	DSM9-SD-03	5V inputs
Stepper motor controller	DSM9-SD-01	24V inputs
Connector set	CK-DSM9	5-pole plug from PCD
		4-pole plug from PCD
Optional heat sink to screw to the chassis side panel	HS6410	with fixing material and heat-conductive sheet
DSM technical description in German	MAEDSM9-SD-D	DSM9-SD_D.pdf
DSM technical description in English: Installation & Hardware Reference Manual	MAEDSM9-SD-E	DSM9-SD_E.pdf

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Sales and Service

We are committed to quality customer service. In order to serve in the most effective way, please contact your local sales representative for assistance.
If you are unaware of your local sales representative, please contact us.

Europe

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