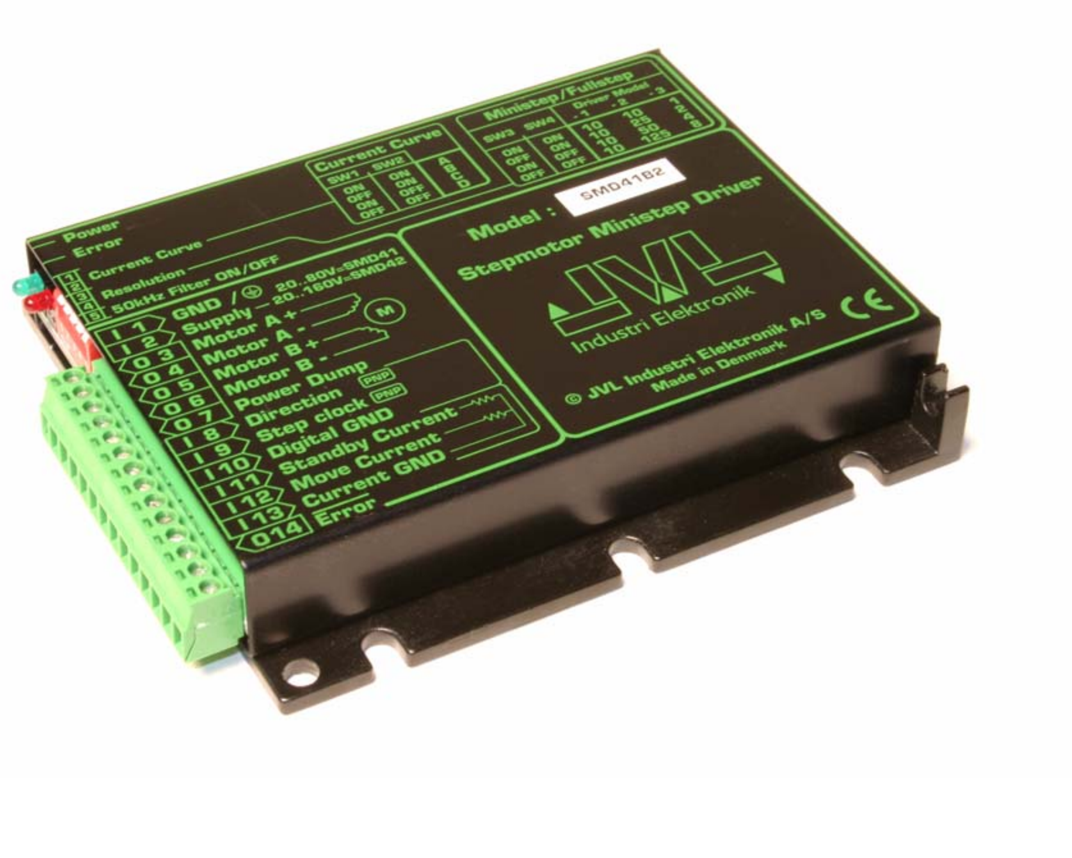
SMD41
and
SMD42

Step Motor Ministep Drivers
User Manual



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LB0043-03GB Updated 10.5.2005

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1.1 Introduction

Step Motor Driver SMD41/42 is a mini-step driver which has been designed for driving step motors with phase currents of up to 9 Amp/phase (RMS).
Driver SMD41/42 is available in 10 different versions for supplying various phase currents and step resolutions up to 25,000 steps per motor revolution.

Overview — SMD41/42 Step Motor Driver Series		
Motor Current per phase	Ministeps per full-step	
	1/2/4/8	10 / 25 / 50 / 125
3Amp/RMS	SMD41A3	SMD41A2
6Amp/RMS	SMD41/42B3	SMD41/42B2
9Amp/RMS	SMD41/42C3	SMD41/42C2

The advantage of using a ministep driver instead of a conventional driver is that mechanical resonance problems are significantly minimised. Resonance most often occurs at slow motor speeds and results either in loss of motor torque or the appearance of significant harmonics. The principle of the ministep technique is to drive the motor using a sinusoidal current in the interval between 2 physical full steps. This reduces the step velocity between each step and thus damps the resonance significantly.

A special feature of the SMD41/42 Driver provides a choice of 4 different curve forms to be used for mini-stepping. Theoretically it is correct to control the motor phase current using a sinusoidal current as mentioned above, but in practice however it is often advantageous to drive the motor using a modified sinusoidal curve since there is not always a linear relationship between the current and the motor position.

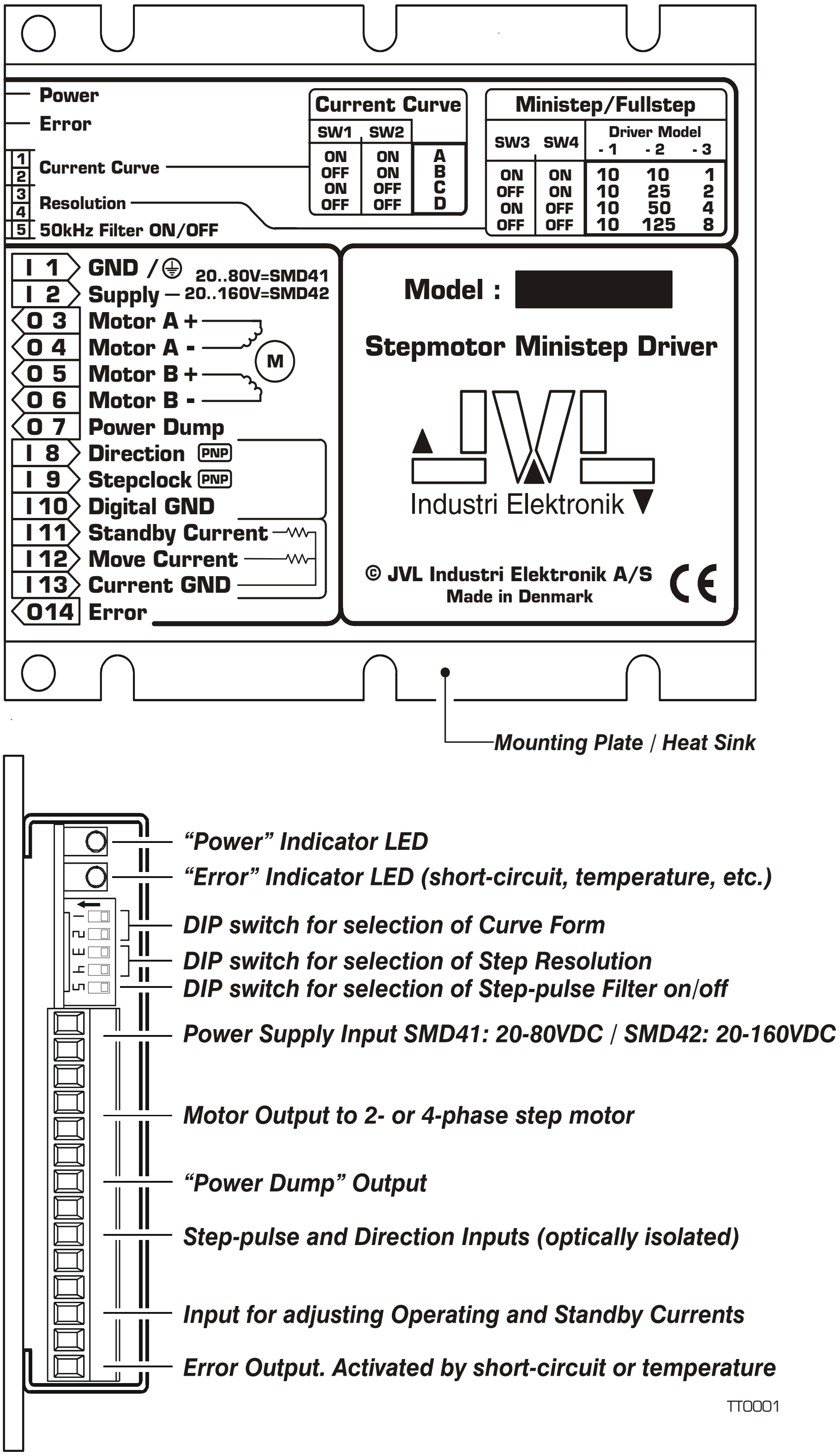
Motor Driver SMD41/42 is built into a black aluminium casing which provides a very robust construction that is insensitive to mechanical vibration. Both 2-phase and 4-phase step motors can be connected to the Driver, which utilises the "Bipolar Chopper" principle of operation, thus giving optimum motor performance.

Main Features:

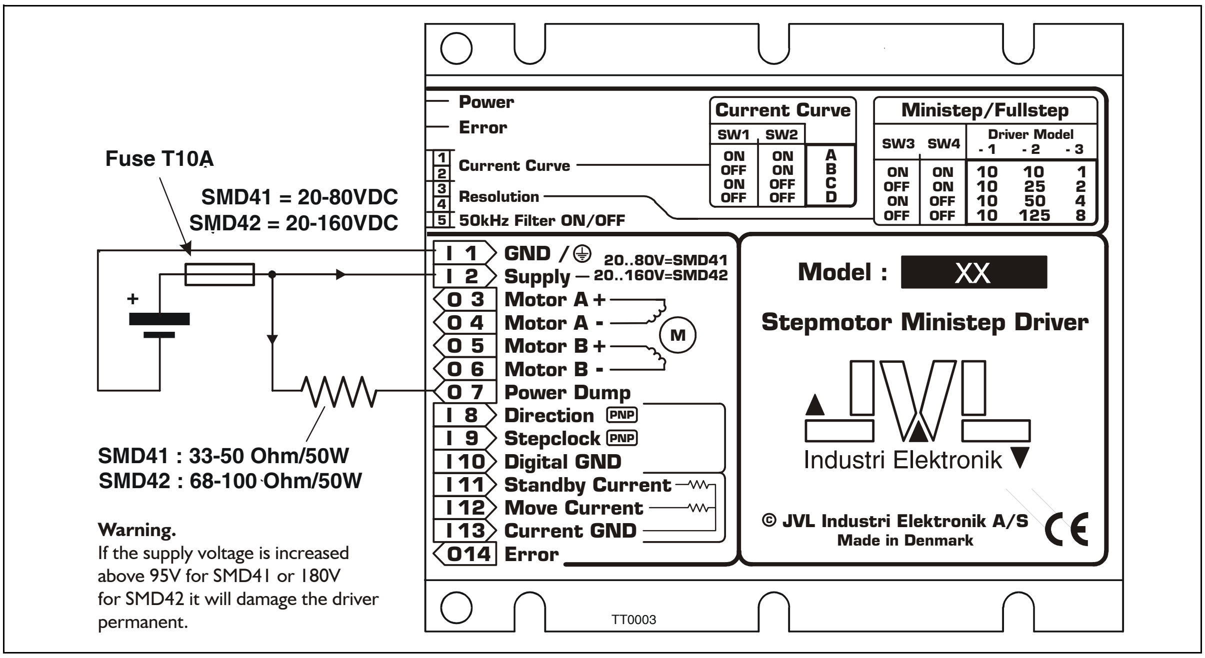
- Wide range of power supply: 20-80 VDC (SMD41) or 20-160VDC (SMD42) .
- Step frequency up to 800 kHz.
- Step Resolution: 200, 400, 800, 1600, 2000, 5000, 10000, 25000 ministeps per motor revolution.
- Galvanically isolated Step-pulse and Direction Inputs.
- "Power dump" output for sinking overloads.
- Automatic switching between Operating and Standby Currents.
- Facility for control of Operating and Standby currents via externally applied voltage 0-2.5V or 0-20mA.
- Small physical dimensions: 100 x 22 x 114 mm
- Error output for temperature overload and short-circuit conditions.
- Thermal overload protection.
- Filter option for Step-pulse Input.
- Compatible with previous model SMD40.

1.2 Driver Connections

Scale 1 : 1



1.3 Power Supply



1.3.1 Power Supply

The power supply for the SMD41/42 is connected to the Driver via terminals 1 and 2. The supply must have an output capacitor of at least 4700μF for optimum operation. To minimise cable induction, this capacitance should not be connected more than 1m from the Driver. 0.75mm cable (minimum) should be used to connect the power supply to the Driver. A T6.3 fuse (SMD41) will do it if you are using 80V and T10A fuse (SMD42) but please keep in mind that it must be a "slow blow" type. The current consumption can be very high during power up since the driver already at 20V try to achieve the selected motor current. The worst case situation is if the driver is setup for full current and is applied with step pulses at the same time during power up.

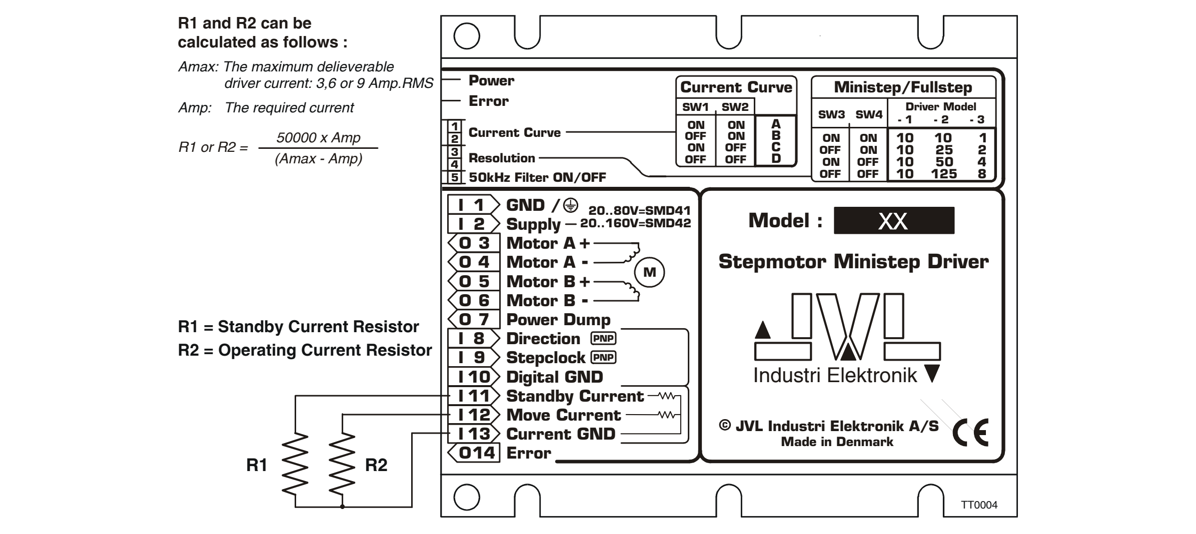
Important!: The SMD41/42 should be protected using a slow-blow fuse of max. 10A since there is no internal fuse. The removable connector must never be removed while power is connected to the SMD41/42 as this will significantly shorten the connector's lifetime.

1.3.2 Power dump

In certain circumstances, the step motor connected to the Driver can induce significant reverse energy surges back to the Driver. This occurs primarily during rapid deceleration of a step motor when large inertial masses are being decelerated. This phenomenon can be problematic since the energy can only be led to the Driver's power supply capacitor, resulting in a large voltage increase.

In situations where the Driver is nominally powered by a voltage of 80VDC (or 160VDC for SMD42), this does not leave any margin for the above-mentioned reverse power surges. In order to solve this problem, the SMD41/42 Driver is equipped with a "safety valve" in the form of terminal 7 (see above illustration). This terminal is connected to a circuit which short-circuits the terminal to ground if the supply voltage exceeds 95VDC (or 180VDC for SMD42). The short circuit is decoupled only when the supply voltage falls below 91VDC(or 168VDC for SMD42). The terminal must be connected to an external resistor, the size of which depends on deceleration parameters. Typically a 30-50ohm/50W (or 68-100 Ohm for SMD42) resistor will be suitable. More specific guidelines cannot be given since the actual energy induced depends on motor data, temperature, deceleration rate, etc.

1.4 Adjustment of Motor Phase Current

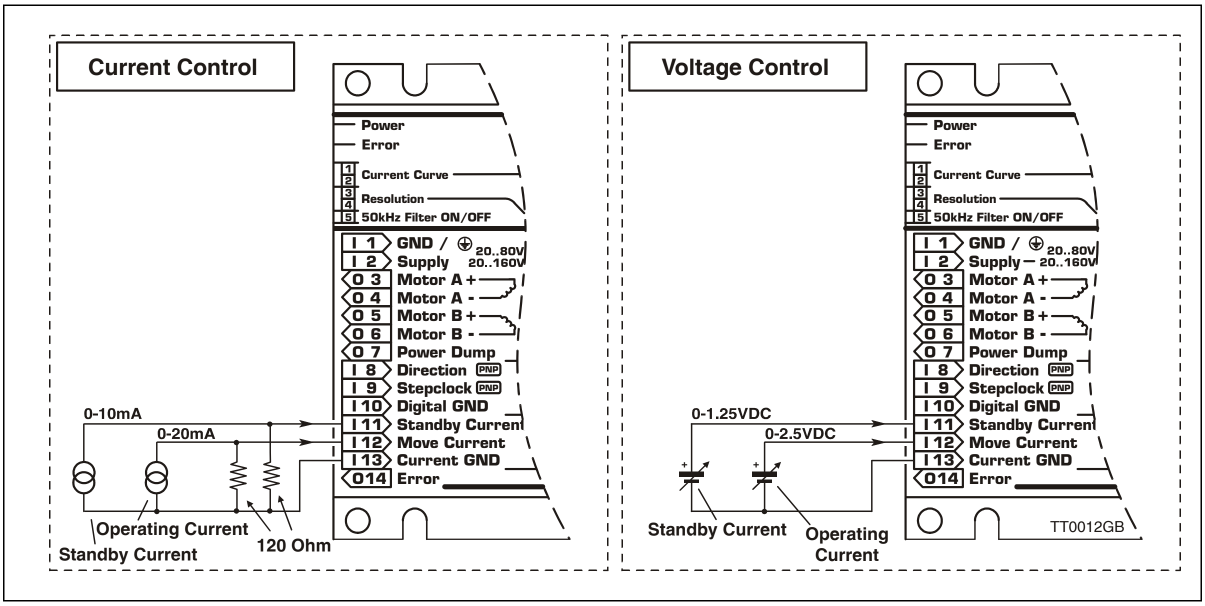


1.4.1 Adjustment of Motor Phase Current

The current supplied to each of the step motor's phases can be adjusted for standby and operating currents using input terminals 11-13. The values of Standby Current and Operating Current are determined, respectively, by the resistor connected between terminals 11+13 and terminals 12+13. The Driver automatically switches between the two currents by detecting the presence of step-pulses. If a rising edge is detected at the stepclock input the "Move current" is selected. If no rising edges is deteccted for 100mS at the stepclock input the current is automatically switched back to "Standby current".
Values for the two currents are typically adjusted so that the Operating Current is significantly higher than the Standby Current, since the motor must be supplied with more power to drive its load during acceleration and constant operation than when it is stationary. Note that the maximum Standby Current can be 50% of the maximum current for the actual driver type. The only overriding consideration that must be made in the adjustment of motor phase currents is that the thermal output of the motor must not exceed the maximum operating temperature of the step motor — see the manufacturer's product data for the motor in question. Note that terminals 11-13 are not galvanically isolated from other Driver circuitry. The following table indicates the relationship between resistor values and motor phase currents. As illustrated, the motor current is also dependent on the model of the SMD41/42 Driver.

Motor Current (Amps RMS per phase)			**Resistor R1-2**
SMD41Ax	**SMD41/42Bx**	**SMD41/42Cx**	**-**
0.00A	0.00A	0.00A	0 Ohm (short-circuit)
0.25A	0.50A	0.75A	4.7kOhm
0.50A	1.00A	1.50A	10kOhm
0.75A	1.50A	2.25A	18kOhm
1.00A	2.00A	3.00A	22kOhm
1.25A	2.50A	3.75A	39kOhm
1.50A	3.00A	4.50A	47kOhm
1.75A	3.50A	5.25A	68kOhm
2.00A	4.00A	6.00A	100kOhm
2.25A	4.50A	6.75A	150kOhm
2.50A	5.00A	7.50A	270kOhm
2.75A	5.50A	8.25A	560kOhm
3.00A (Maximum)	6.00A (Maximum)	9.00A (Maximum)	none (open circuit)

1.4 Adjustment of Motor Phase Current



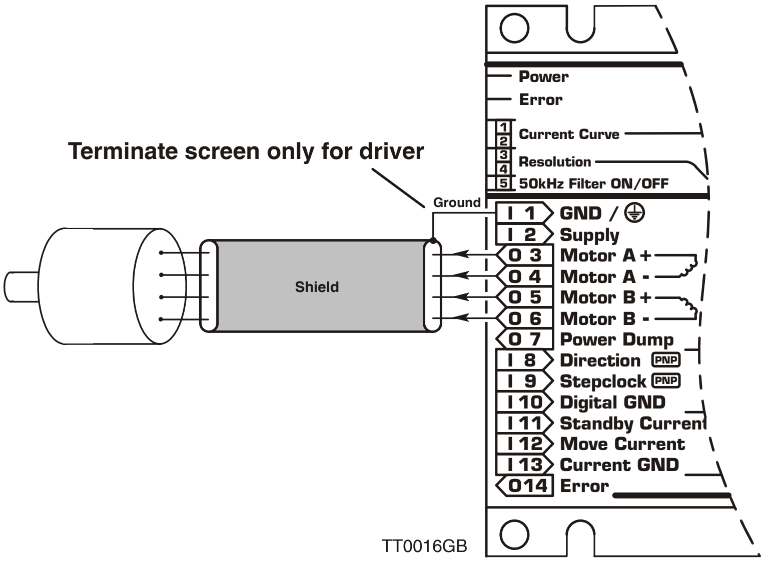
1.4.2 Motor Current Controlled by Voltage or Current

In cases where current control is not desired via an external resistor, but via an externally applied voltage, terminals 11-13 can also be used.

A voltage in the range 0 to 2.50VDC should be applied to the two terminals, corresponding to motor currents of 0 to 3Amp for SMD41Ax, 0 to 6 Amp for SMD41/42Bx, and 0 to 9 Amp for SMD41/42Cx.
If current control of the motor phase current using a standard signal in the range 0-20mA is required, a 127 Ohm/1%(E48) or 120 Ohm/5%(E24) resistor should be connected between "Current GND" and each input — see above illustration.

The relationship between the voltage at the terminals and the motor current is liniar from 0 to full-scale.

1.5 Connection of Motor



1.5.1 Cabling

For Driver models that supply a phase current in the range 0 to 6 A, it is recommended that 0.75mm² cable (minimum) is used to connect the motor to the Driver.
For Driver models that supply a phase current in the range 0 to 9 A, it is recommended that 1.5mm² cable is used to connect the motor to the Driver.
Cable lengths used to connect the motor to the Driver should not exceed 10 metres because of impedance loss.
Connected cables should be securely tightened since a poor connection can cause heating and destruction of the connector terminals. Similarly, tinned conductors should be avoided. The torque used for each screw is recommended in the range 0.22 - 0.25Nm.

Important!
To minimise spurious noise emission from the motor cables and fulfil CE requirements, screened cable must be used!
If screened cable is not used, other electronic equipment in the vicinity may be adversely affected.

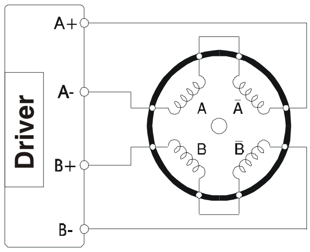
The removable connector must never be removed while a voltage is connected as this will significantly reduce the lifetime of the connector. Note also that the connector's lifetime is reduced by repeated connecting/disconnecting since the contact resistance of the pins is increased.

Note that GND (1) is connected to the chassis and functions as the main ground on the SMD41/42.

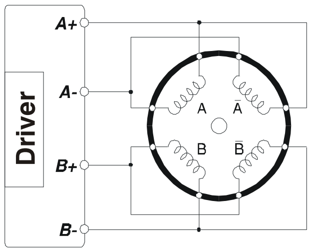
See also *Motor Connections,* page 21, which describes how various models of motor should be connected to the SMD41/42.

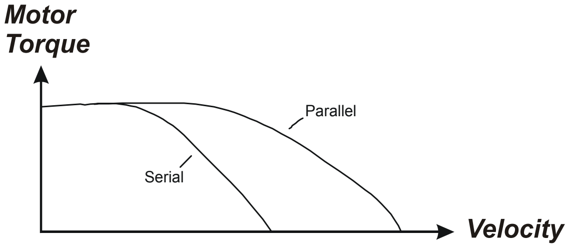
1.5 Connection of Motor

Serial connection of phases:



Parallel connection of phases:





Current for Serial or Parallel connection

	Maximum current settting	Example motor 4.2A
Motor 4-phase parallel	I x 1.41	4.2 x 1.41 =5.9
Motor 4-phase serial	$\frac{I}{1.41}$	$\frac{4.2}{1.41}$ = 3A
Motor 2-phase	I	4.2A

I = Nominal current per phase in accordance with manufacturer's specifications

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1.5.2 Connection of Step Motor

Various types of step motor are available:

1. 2-phase Bipolar (4 cables)
2. 4-phase Bipolar/Unipolar (8 cables)
3. 4-phase Unipolar (6 cables). Not suitable.

Note that Type 3 motors indicated above (Unipolar motors) are not suitable for operation with this series of Drivers since the Drivers utilise the bipolar principle.

Note that a bipolar system typically yields 40% greater torque than unipolar systems.

2-phase or 4-phase motors can be connected to the Drivers as follows:

2-phase Motors (4 cables).
This type of motor can be directly connected to the Driver's output terminals.
The Driver current adjustment must not exceed the manufacturer's specified rated current for the motor.

4-phase Motors (8 cables).
This type of motor can be connected to the Driver in one of the 2 following ways:

1. Serial connection of phases.
2. Parallel connection of phases.

Selection of serial or parallel connection of the motor phases is typically determined by the speed requirements of the actual system.
If slow speeds are required (typically less than 1 kHz), the motor phases can be connected in serial. For operation at higher speeds (greater than 1 kHz), the motor phases can be connected in parallel.

1.5 Connection of Motor

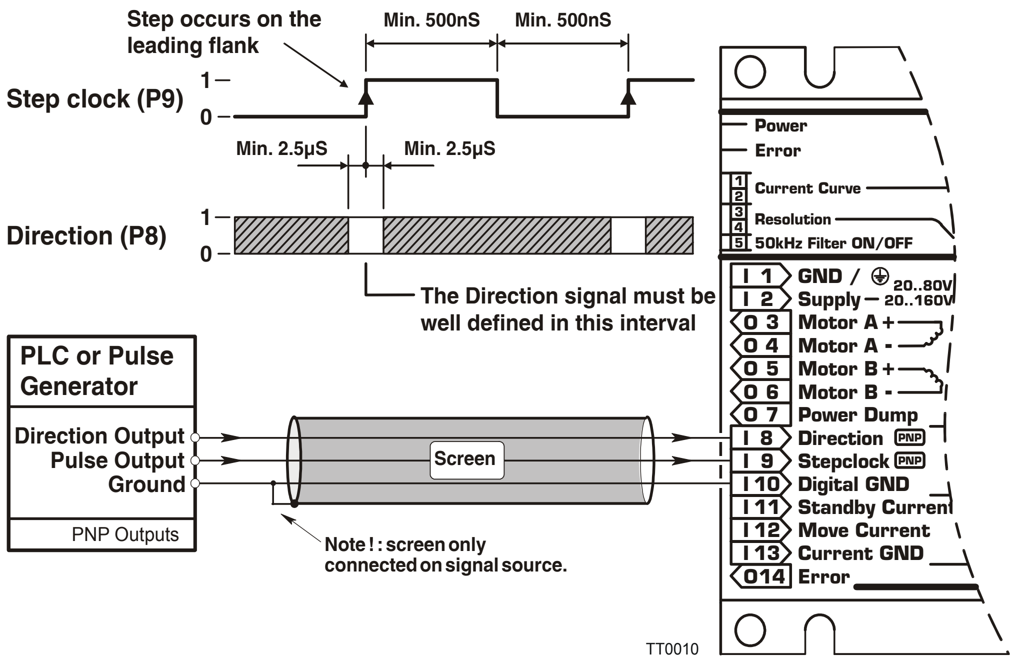
Serial Connection:
Using serial connection of the phases, a motor provides the same performance (up to 1kHz) as parallel connection, but using only approximately half the current. This can influence the selection of Driver model and enables a Driver rated for a lower motor current to be used. See illustration on previous page.
If the phases of a 4-phase step motor are connected in series, the motor's rated phase current should be divided by 1.41. For example, if the rated current is 4.2A, the maximum setting of the Driver phase current must not exceed 3 A when the motor phases are connected in series.

Parallel Connection:
With parallel connection of motor phases, a motor will provide better performance at frequencies greater than 1kHz compared to serially connected phases, but requires approximately twice the current. This can influence the choice of Driver since it is necessary to select a Driver that can supply twice the current used for serial phase connection. See illustration on previous page.
When the phases of a 4-phase motor are connected in parallel, the specified rated current of the motor must be multiplied by a factor of 1.41. For example, if the rated current is 4.2 A, the maximum setting of the Driver phase current must not exceed 5.9 A when the phases are connected in parallel.

It should be noted that the lower the self-induction of the motor the better since this influences the torque at high speeds. The torque is proportional to the current supplied to the motor.

The applied voltage is regulated by the Driver so that the phase current is adjusted to the selected value. In practice this means that if a motor with a large self-inductance (e.g. 100mH) is used, the Driver cannot supply the required phase current at high speeds (high rotational frequencies) since the output voltage is limited.

1.6 Step Pulse and Direction Inputs



1.6.1 Step Pulse and Direction Inputs

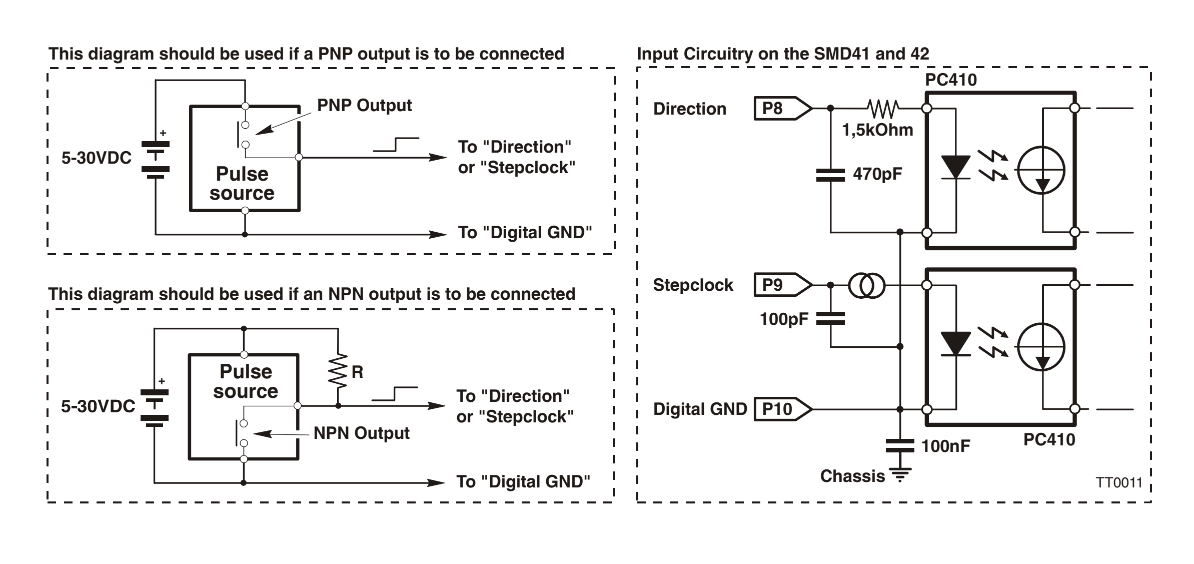
The 2 main inputs on the SMD41/42 are the Step Pulse and Direction Inputs shown in the above illustration. The Step Pulse Input is used for applying pulse signals which make the motor move. One signal pulse corresponds to a single ministep. The Direction Input determines the direction of the motor movement. If logic "1" is applied to the Direction Input, the motor moves forward. If logic "0" is applied to the Input, the motor moves backwards.
Both the Step Pulse and Direction Inputs are optically isolated from other Driver circuitry and must be driven either by a push-pull driver or a PNP (source) driver. The Inputs can handle voltages in the range 0 to 30 V, which makes the SMD41/42 well suited for industrial applications, for example in PLC systems.
Optical isolation of the Inputs ensures that the SMD41/42 is not affected by extraneous electrical noise.
Both Inputs are partly current driven, which also contributes to the Driver's noise immunity, particularly if the signal source is located at a distance from the Driver. It is, however, recommended that screened cable is always used for connection to the Step Pulse and Direction Inputs.

Both inputs must be controlled from a "Source-driver". This means that they share a common ground — see above illustration.
The Driver executes the step on the leading flank of the Step Input pulse — see above illustration.

1.6.2 Input Filter

In situations where the step-pulse signal's rise and fall time is very slow - > 1 μS, it is recommended that the built-in Input Filter is used. The Filter is enabled by setting DIP switch 5 to the "ON" position. This limits the bandwidth of the Step Pulse Input to <50kHz.
Note that the pulse width must be > 10 μS if the Input Filter is used.

1.6 Step Pulse and Direction Inputs



1.6.3 Signal Source with NPN Output

Normally the output circuit of the signal source is regarded as a PNP output to comply with European Standard. However there are a number of PLC controllers or PC axis boards that use an NPN output.
To connect these NPN systems to the SMD41/42, a "pull up" resistor must be used, as shown in the above illustration.

The size of the resistor depends on the actual signal source used. Use the following table to determine the required resistance.

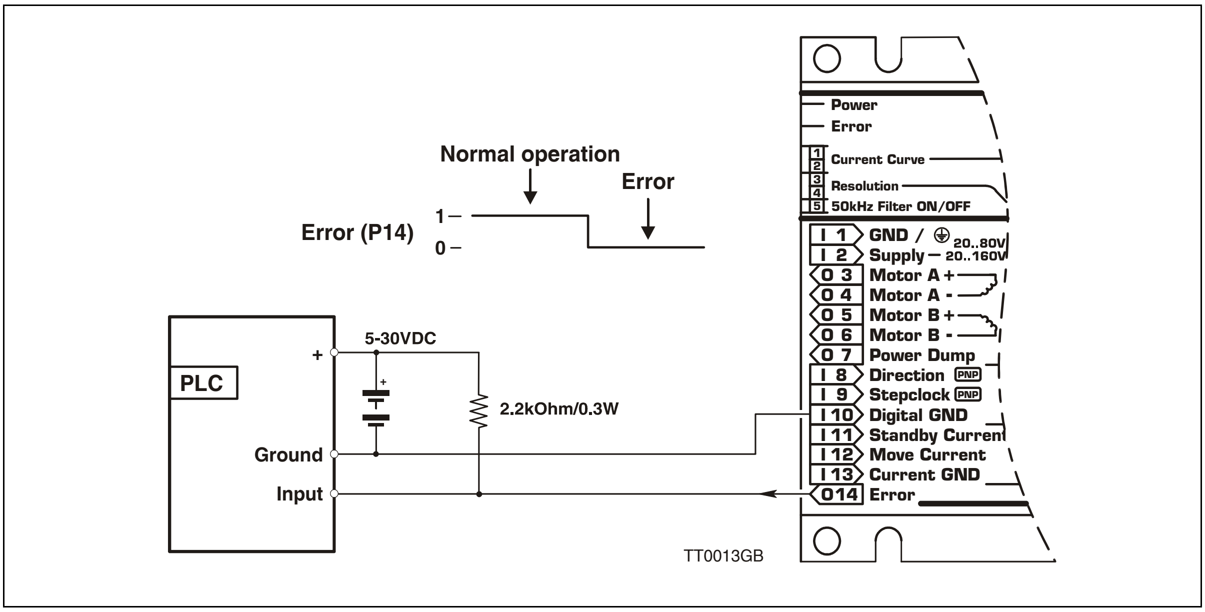
Voltage	Resistance (R)
5-8VDC	470 Ohm
8-14VDC	1.5 kOhm
14-20VDC	2.2 kOhm
20-30VDC	2.7 kOhm

It is recommended that a resistor type SFR25 (0.5W) or SFR16 (0.3W) is used.

1.6.4 Input Circuitry

As shown in the above illustration, the Driver's input circuitry is galvanically isolated from other circuits.
This prevents ground loops that could cause unwanted errors in the step pulse and direction signals. Note that the Inputs' ground (Digital GND) is also used for the Error Output P14.

1.7 Error Output



1.7.1 Error Output

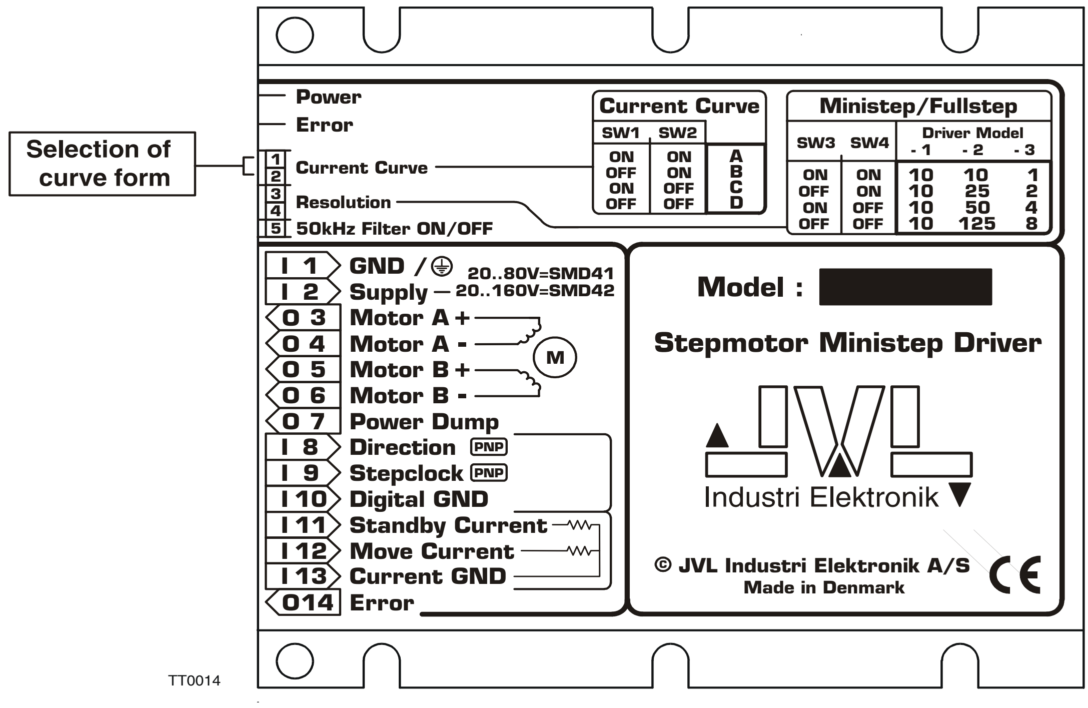
The Driver's Error Output enables a PLC or other equipment in a motion control system to verify that the Driver is functioning correctly.
Under normal operation the Error Output has a status of logic "1", but if the Driver is short-circuited or the temperature exceeds 85 degrees Centigrade, the Output is switched to logic "0".

Note that the Output is of the NPN type and must therefore have a "Pull up" resistor connected to the actual supply (0-30VDC).
For a PLC system operating with 24V levels, a 2.2kOhm resistor will typically be required.
This relatively low resistance is necessary to maintain a current of 10mA, which is typically required for a PLC input to be activated.

For 5V logic inputs, a resistance of 1kOhm is recommended.

Note that the Error Output has a maximum rated loading of 50mA and is not short-circuit protected!

1.8 Selection of Curve Forms



1.8.1 Selection of Curve Forms

The mini steps normally use a sinusoidal curve to drive the motor.

For some types of step motor, the relationship between current and the step motor's position is not completely linear.
In such cases, it is possible to modify the sinusoidal curve and thus achieve better and more precise positioning of the motor.

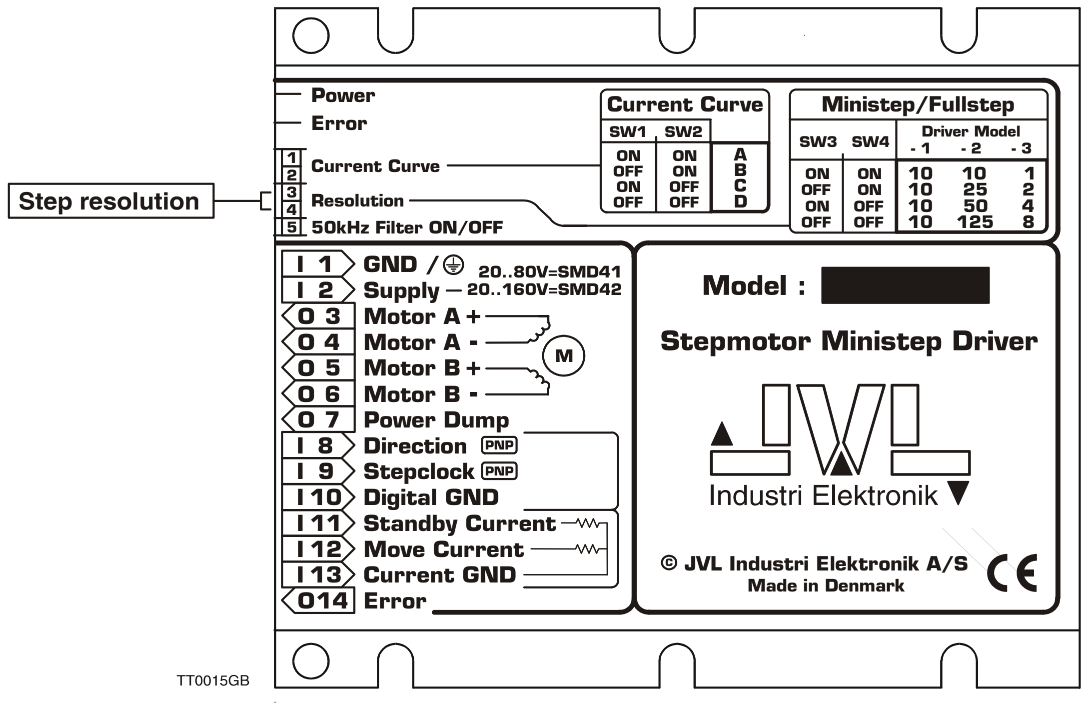
Using 2 DIP switches on the Driver (see above illustration), it is possible to operate the motor using 1 of 4 different curve forms: ideal sinusoidal curve, sine + 3%, sine + 6% or sine - 3%.

The DIP switch settings are given below:

DIP-switch settings		Curve form
ON	ON	Curve A - Ideal sine
OFF	ON	Curve B - Sine +3%
ON	OFF	Curve C - Sine +6%
OFF	OFF	Curve D - Sine -3%

Contact JVL if external control of the selection of the curve form is required.

1.9 Selection of Step Resolution



1.9.1 Step Resolution

The SMD41/42 series comprises 3 different step resolution groups.
SMD41/42x3 has the lowest resolution and SMD41/42x2 has the greatest.
The following table shows the step resolutions that are available. The values "per revolution" are based on a standard motor with 200 steps per revolution.

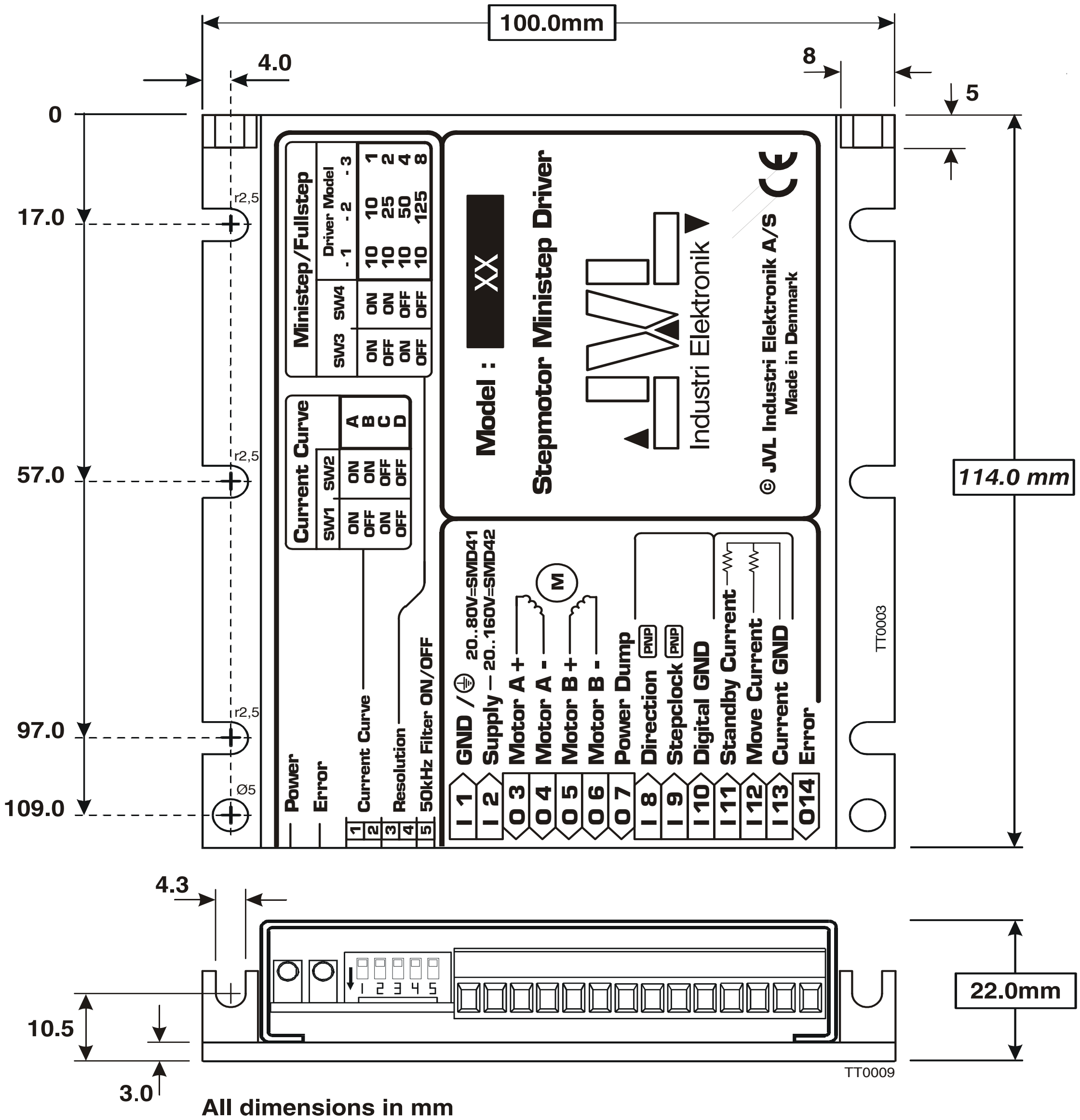
Type	Mini steps/full step	Mini steps/revolution
SMD41/42x2	10, 25, 50, 125	2000, 5000, 10000, 25000
SMD41/42x3	1, 2, 4, 8	200, 400, 800, 1600

For Driver models SMD41/42x2 and SMD41/42x3, the ministep resolution can be adjusted using 2 DIP switches on the side panel of the Driver — see above illustration.

Use of higher step resolution minimises mechanical resonances and thus provides optimum motor torque throughout the entire range of velocity. Note that the motor's resonances/torque is also heavily determined by the supply voltage. At high supply voltages, optimum torque is achieved at high rates of revolution.

Contact JVL if control of step resolution from an external unit is required.

1.10 Physical Dimensions



All dimensions in mm
Tolerance +/- 0.1 mm

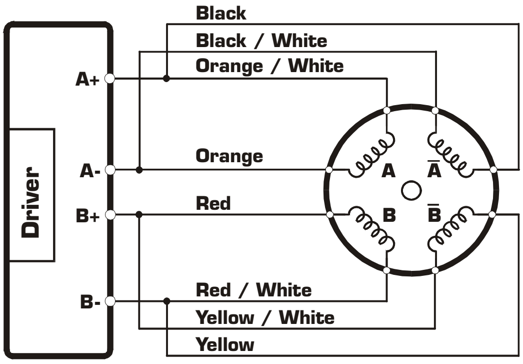
1.11 Technical Specifications

	Minimum	Typical	Maximum	Absolute maximum	Units
Power Supply:					
SMD41 : Supply Voltage - nominal	20		80	90	VDC
SMD42 : Supply Voltage - nominal	20		160	70	VDC
Current Consumption, without motor	35 @80V	67 @40V	170 @20V	-	mADC
Driver Stage:					
Chopper Frequency	20		24	-	kHz
Motor Current (per phase)	0.0		(3, 6, 9)*	-	A RMS
Power Loss in Driver (Watt per A RMS)		1.5		-	Watt
"Power Dump" Output:					
Continuous Current			2	-	ADC
Voltage SMD41(42)	0		90 (180)	100 (200)	VDC
Step Pulse Input:					
Voltage Logic "1"	4.3		28	32	VDC
Voltage Logic "0"	0		3.0	-	VDC
Current Logic "1"	8		12	-	mADC
Current Logic "0" (open)	0		3	-	mADC
Pulse Duration - Logic "1"	500			-	ns
Pulse Duration - Logic "0"	500			-	ns
Rise Time			100	-	ns
Decay Time			100	-	ns
Frequency	0		800	-	kHz
Frequency (with Step Filter - DIP 5)	0		50	-	kHz
Direction Input:					
Voltage Logic "1"	4.3		28	32	VDC
Voltage Logic "0"	0		3	-	VDC
Current Logic "1" (source)	10		20	-	mADC
Current Logic "0" (open)	0		3	-	mADC
Current Control Inputs:					
Input Impedance		50		-	kOhm
Input Voltage	0		2.50	5.0	VDC
Diverse:					
Temperature range (ambient)	-20		45	-	°C
Temperature alarm (internal temp.)		85		-	°C
Humidity	0		95	-	%
Weight	-	250	-	-	gram
Recommended Heat Sink Data SMD41Ax	0	-	-	-	K/W
Recommended Heat Sink Data SMD41Bx	2	1	-	-	K/W
Recommended Heat Sink Data SMD41Cx	1	0.6	-	-	K/W
Recommended Heat Sink Data SMD42Bx	1	-	-	-	K/W
Recommended Heat Sink Data SMD42Cx	0.6	-	-	-	K/W

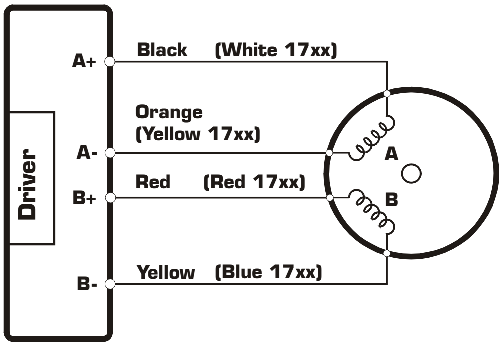
* SMD41Ax - 3A RMS /SMD41/42Bx - 6A RMS/ SMD41/42Cx - 9A RMS

1.12 Motor Connections

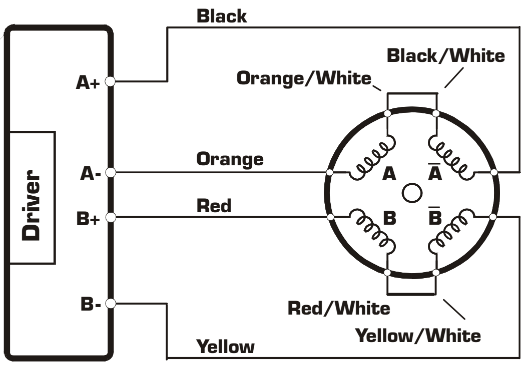
Connection of JVL and MAE motors (parallel). Type MST23x/ MST34x and HY200-xxxx-xxx-x8



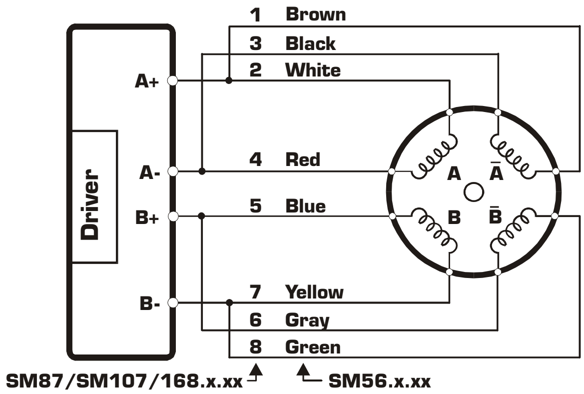
Connection of JVL and MAE 4 wire motors. Type MST17x and HY200-xxxx-xxx-x4



Connection of JVL and MAE motors (serial). Type MST23x/ MST34x and HY200-xxxx-xxx-x8

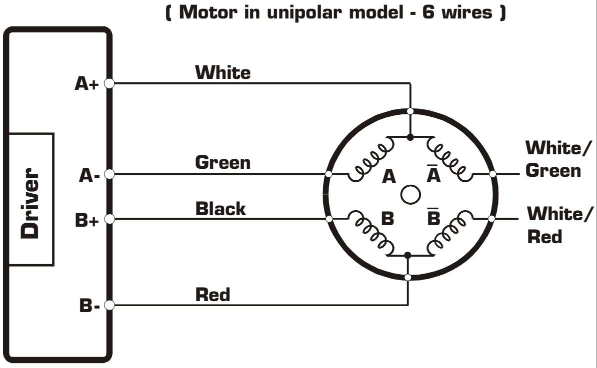


Connection of Zebotronics motor Type : SMxxx.x.xx.x (8 terminals)

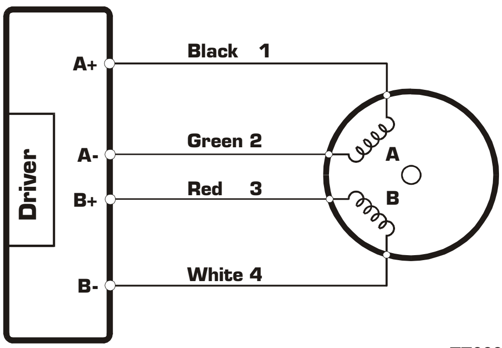


Connection of MAE motor (unipol.) Type HY200-1xxx-xxxxx6

(Motor in unipolar model - 6 wires)



Connection of Zebotronics motor Type : SMxxx.x.xx.x (4 terminals)



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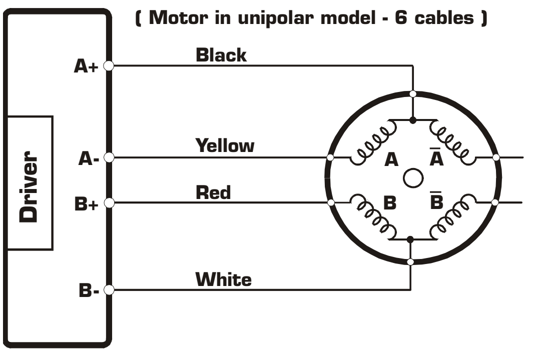
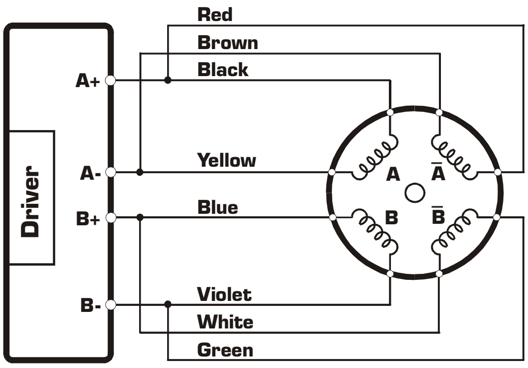
1.12 Motor Connections

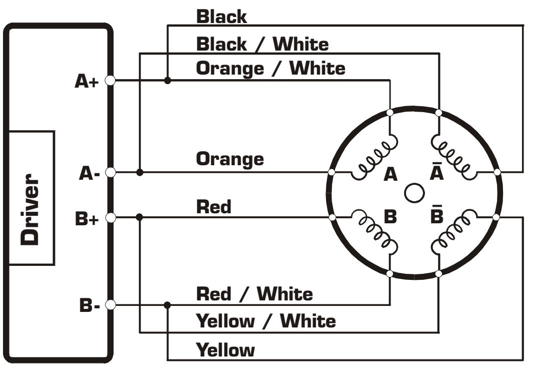
Connection of Vexta motor Type PH2xx.xxx



Connection of Phytron motor Type ZSx.xxx.x,x

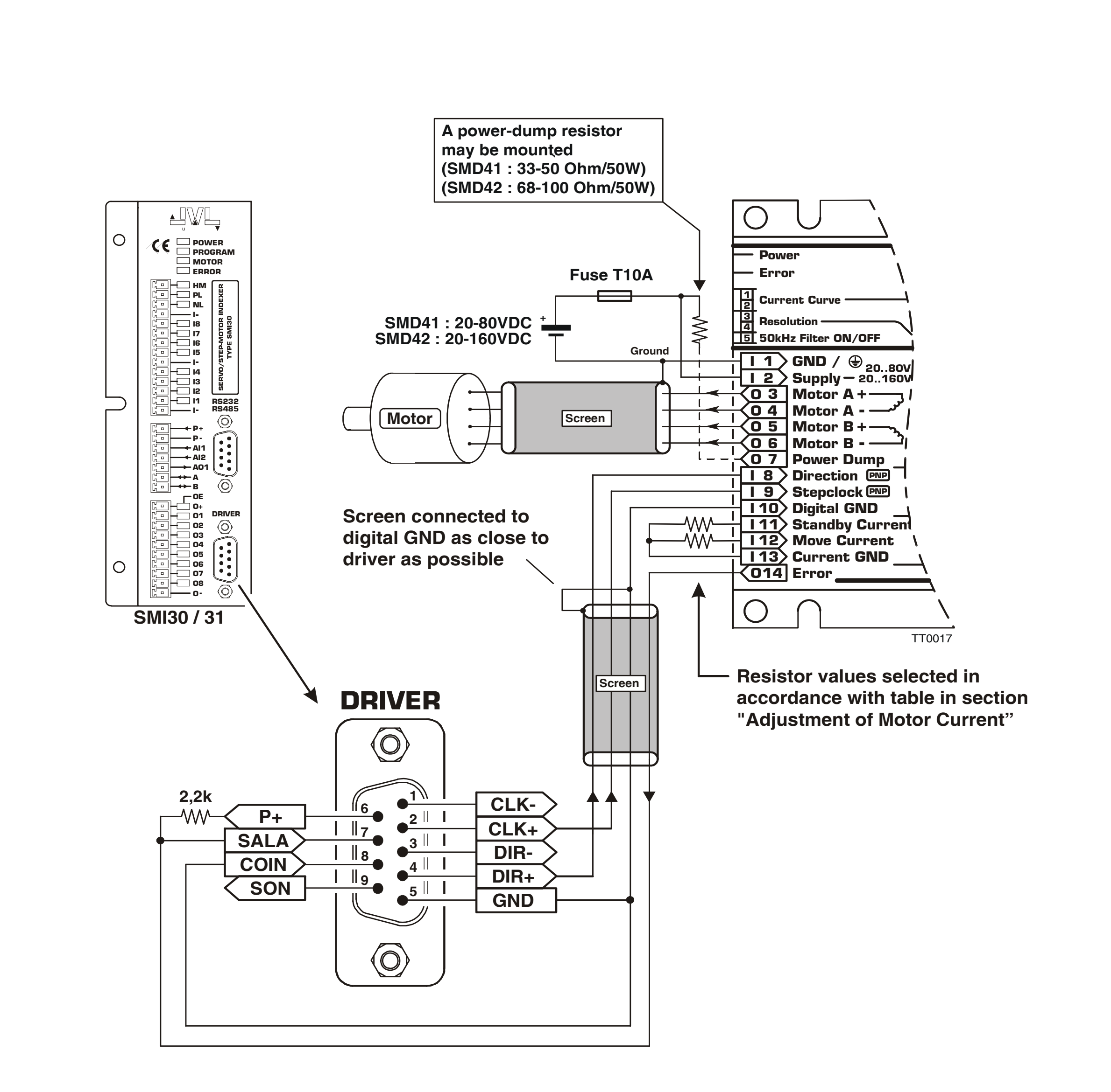


Connection of Vexta stepmotor Type : PH2xx-xxx



TT0006

1.13 Connection to Indexer SMI30



1.13.1 Connection to Indexer SMI30

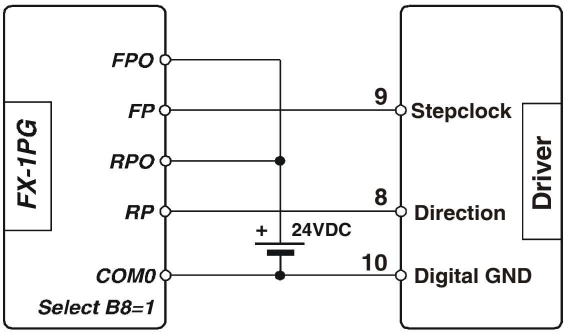
The above illustration shows how a typical connection is made between the SMD41/42 and JVL Indexer SMI30 or SMI31. It is recommended that screened cable is used for connecting the motor and the logic signals to the SMI3x in order to avoid spurious noise problems and to fulfil the requirements of CE conformity for the complete system.
It is recommended that the cable length between the SMI3x and SMD41/42 does not exceed 2 m.
The following SMI3x registers must be set:

PR Pulses per motor revolution. This register must be set according to the number of steps per revolution selected on the SMD41/42.

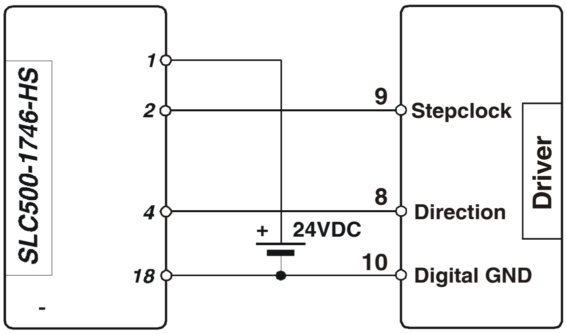
CB15 Control flag for SALA (servo alarm). This flag is set to CB15=1 so that the SMI3x accepts logic 0 as the active level for the SALA input. This means that the SMI3x detects any error from the SMD41/42 when the "Error" Output goes to logic 0.

1.14 Connection to PLC / PC Boards

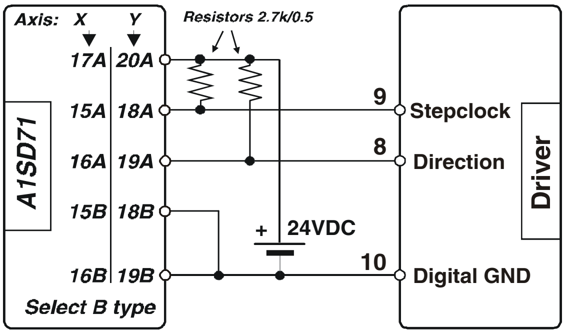
Connection to Mitsubishi PLC
Step motor adaptor type FX-1PG



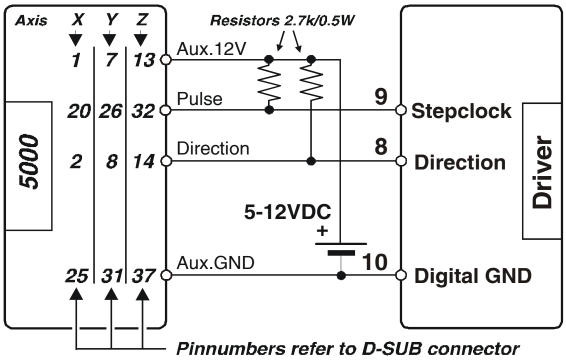
Connection to Allen Bradley PLC
Step motor adaptor SLC500-1746-HS



Connection to Omron PLC
Step motor adaptor type A1SD71



Connection to Tech80 PC-board
Board type 5000



TT0007

1.15 Accessories

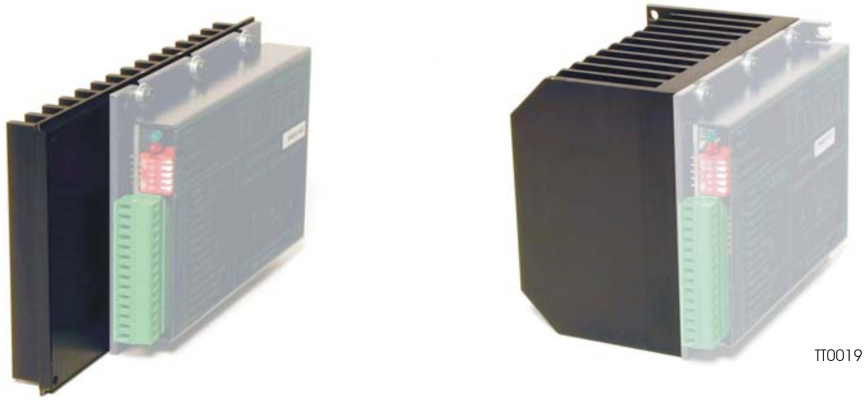
The following accessories are available for use with the SMD41/42.

MM3101 Heat Sink Plate 100 x 160 x 15 mm. Thermal resistance 1K/W.
The Heat Sink Plate is ready for mounting in a 19" rack. Screws for mounting the SMD41/42 are included.
MM3101 is suitable for all models of the SMD41/42.

MM3103 Heat Sink Plate 100 x 114 x 67.5 mm. Thermal resistance better than 0.6K/W.
The Heat Sink Plate is ready for "wall" mounting. Screws for mounting the SMD41/42 are included. MM3103 is suitable for all models of the SMD41/42.

Heatsink for 19" rack mounting type MM3101

Heatsink for "wall" mounting type MM3103



RP0001 Power dump resistor 33 Ohm/50W. Dimensions: 16x50x16mm excluding connection terminals and mounting flanges.

CS0002 14-pole Connector. This connector is always mounted on the SMD41/42 on delivery and is standard.
If the connector is lost or becomes damaged, a new one can be ordered using this number.

SMI30 Step Motor Indexer. The SMI30 is a programmable Indexer which can be used as a stand-alone unit for executing user programs for motor control using positioning and various speeds. The SMI30 is based on a motor processor that can generate step pulse frequencies up to 2MHz. See *Connection to Indexer SMI30,* page 23, for further details.

Cables JVL can supply customised cables for specific applications. Contact JVL for further information.

1.16 CE Declaration of Conformity

EU - Declaration of Conformity

We hereby declare that the followiing eqipment fulfils the protection requirements of Council Directive 89/336/EEC on electromagnetic compatibility (EMC).

Identification of equipment

Category: *Motor Controller*

Manufacture:*JVL Industri Elektronik A/S*

Type: *SMD41A/B/C, 1/2/3 Step Motor Ministep Driver*
SMD42A/B/C, 1/2/3 Step Motor Ministep Driver

Manufacturer's Data:
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Blokken 42
DK-3460 Birkerød
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Fax. +45 45 82 55 50
E-mail: jvl@jvl.dk
Internet: http://www.jvl.dk

The following standards have been used as the basis for this declaration:
Emission - EN50081-2 1993
Immunity - EN50082-2 1994

Notes:
The CE-mark only imdicates conformity with EMC-direktive 89/336/EEC

Date 1st.January 1999
Bo V. Jessen
Technical Director

TT0018

Revideret 14.2.1996

1.18 Index