MM 2.5

Microstepper Translator / Driver Card

OPERATION AND INSTALLATION

MANUAL

FOR MM SERIES

WITH OPTICAL ISOLATION INTERFACE

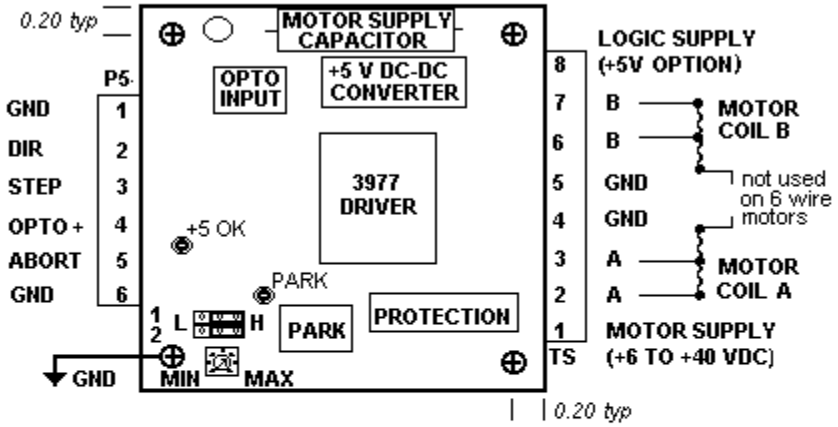
FOR +24 VDC SINKING

THE MOTION GROUP
SERVICE CENTER
800-424-STEP
motiongroup.com
PO BOX 669 CLOVIS, CA 93613-0669 TEL: 559-325-2727 FAX: 559-325-7117

MM 2.5 MICROSTEPPING MOTOR DRIVER

WIN\MS\MM25SYS.BMP 10-02

2.5 AMP/COIL WITH CURRENT ADJUST & AUTO-PARKING ™



The MM 2.5 stepping motor driver is intended for high power - high speed OEM applications. Max current is 2.5 amps @ 40 vdc max. Driver includes full protection. Option packages include Lo Profile metal case, flat cable connectors or de-plug screw terminal, on-card +5 supply. Special features: mid-resonance compensation, power reduction (45%) at standstill, limits & home sensor connections, mid-freq power boost, automatic decay control and calibrated current adjustment. Max step is 100 k s/sec. Drives any motor; 2 or 4 phase, 4, 5, 6, or 8 leads. Guaranteed operation +/- zero steps.

P5 CONNECTOR SCREW TERM PLUG (20 PIN IS OPTIONAL; SEE APP. A)	
P5-1	GROUND (COMMON TO CHASSIS)
P5-2	DIRECTION INPUT; HI=CW, LO=CCW
P5-3	STEP INPUT; NORMALLY HI, PULSE LO, STEP ON RISING EDGE
P5-4	OPTO INPUT SUPPLY VOLTAGE; +3.3 TO +28 VDC MAX.
P5-5	ABORT LOOP; CLOSE=ENABLE, OPEN=FREE; NOT OPTO ISOLATED
P5-6	GROUND

TS CONNECTOR SCREW TERM PLUG	
TS-8	+5 VDC SUPPLY OUT/IN / TEST
TS-7	MOTOR COIL B
TS-6	MOTOR COIL B
TS-5	GROUND (SUPPLY RETURN)
TS-4	GROUND (SUPPLY RETURN)
TS-3	MOTOR COIL A
TS-2	MOTOR COIL A
TS-1	MOTOR SUPPLY (+6 TO +40 VDC)

DRAWING SYMBOLS

PARK LED; OFF=PARK, ON=STEPPING, ALWAYS OFF=NO ENABLE (ABORTED)
PARKING IS 45% OF CURRENT ADJUST

CURRENT ADJUST POTENTIOMETER, 270° ROTATION MAX.
SET TO PERCENTAGE OF 2.5 AMPS OF RATED MOTOR CURRENT PER COIL

STEP ANGLE SELECT JUMPER BLOCK; JUMPER PER TABLE

1 2	STEP ø
L L	1:1
L H	2:1
H L	4:1
H H	8:1

MOTOR SUPPLY CAPACITOR — TOTAL CAPACITY OF DRIVER CAP & MOTOR SUPPLY CAPS MUST EQUAL 1000 uf PER AMP OF MOTOR CURRENT

+5 V DC-DC CONVERTER — OPTIONAL; NOT REQUIRED WHEN ENTIRE MOTION SYSTEM USES COMMON +5 VDC LOGIC SUPPLY; 5V JUMPER MUST BE INSTALLED. DC-DC CAN SUPPLY 500MA TO MOTION SYSTEM

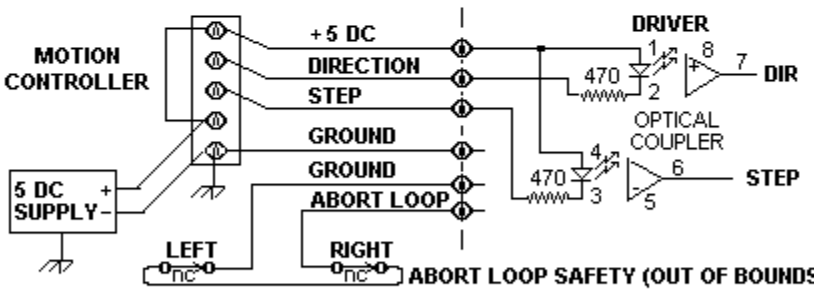
OPTO INPUT — OPTIONAL; NOT REQUIRED WHEN ENTIRE MOTION SYSTEM USES COMMON +5 VDC LOGIC SUPPLY

PROTECTION — OVER-CURRENT, OVER-VOLTS, OVER-TEMP WITH 5 AMP FIRE FUSE ON MOTOR SUPPLY INPUT. NEVER REPLACE FUSE; FUSE FAILURE INDICATES DRIVER FAILURE; CALL FOR SERVICE.

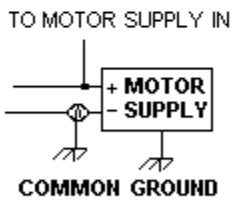
DIMENSIONS (OPTION CODE)	
2.50" SQ. x 0.50" HIGH WITHOUT HEAT SINK & OEM HEADER CONNECTIONS	(CD)
2.50 x 2.50 x 1.10" HIGH W/ VERTICAL CONNECTORS	(VP)
2.50 x 3.70 x 1.10" HIGH W/ HORIZONTAL CONNECTORS	(HP)
3.50 x 3.80 x 0.65" HIGH W/ ALUMINUM CASE & HORIZONTAL CONNECTORS 3.25 x 2.75 MOUNTING CENTERS	(CA)

OPTION CODES	
OPTICAL ISOLATION	OP
FLAT CABLING	20
+5 DC-DC SUPPLY	S5

TYPICAL +5 V CURRENT SINK TO DRIVER OPTO INTERFACE



CAUTION: HIGH-CURRENT CHOPPER DRIVE. MOTOR POWER OFF WHEN CONNECTING !



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PRODUCT DESCRIPTION

The MM, Series 2.5 stepper motor driver, is a switching type, constant- current regulator which drives current pulses through the windings of a stepper motor. All stepper motors are stepped or rotated by changing the direction of the current flow through the windings in a unique sequence. Each change of current direction results in a step.

The driver contains two sections: (1) the step generator; and the (2) power drivers. The step generator is a digital logic system which receives input commands from a controller (typically a microprocessor) and generates a series of step signals. The power drivers receive the step signals and switch the phase of current in the motor windings.

The driver requires a minimum of three input signals: (1) the step pulse - STP, (2) the direction level - DIR, and (3) the enable signal - ABR. The step pulse (or step clock) to the input of the driver will cause a corresponding change of the output current resulting in one step (one unit of motor rotation). The direction input is a digital level signal which controls the direction of motor rotation. If the signal is true (HIgh), the motor rotates in CW direction; if the signal is false (LOw), the motor rotates in CCW direction. The enable signal, ABoRt, sets the current to either off or on. If the signal is HI or floating, the driver is FREE (no current); if LO, the driver is enabled.

In addition to the digital input signals, the MM driver also requires a power supply input of unregulated D.C. voltage. The driver functions to control the current furnished by the D.C. supply. The combination of a D.C. supply and the MM driver is referred to as a current-regulated power supply, or constant- current motor driver. The driver regulates the current through the motor winding by rapidly switching on and off the D.C. voltage. This technique is referred to as switch-mode or chopper stabilized regulation. The NON-OPTICALLY ISOLATED driver also requires +5 TTL logic supply for the digital sections.

STEP ANGLES

The driver can be operated in four step sizes: FULL-step or HALF- step, QUAD-step, and OCTAL-step.

PARK CONTROL During operation, the output power is controlled automatically; when stepping output power is 100% of the current control pot setting. When stationary, the power is reduced to 40%. Parking is used to reduce driver and motor heating during non-step periods.

THEORY OF OPERATION

The unique element in the driver is the current regulator device, referred to as the "driver chip". This driver has three main inputs: (1) the phase-control, F; (2) current-control, I0; (3) current-control, I1. The outputs of a driver are the connections to a single motor winding. Internally an output section contains four power transistors configured in an H-bridge with two pair sourcing current and two pair sinking current. The motor winding is connected across the bridge. If one source transistor (at one end of the winding) and one sink transistor (at the other end) are turned on, then current flows through the winding. Alternately, if the other pair is on, then the current will flow through the windings in the opposite direction. The D.C. Supply is connected to the top (positive) and bottom (negative) of th H-bridge transistor pairs. An external resistor (typically 1 ohm or less) is inserted in series between the negative of the H-bridge and the negative of the power supply negative so that the total winding current flows through the resistor. When full winding current flows, the small voltage (400 mv) across the resistor is fed back to the comparator section and turns off the H-bridge transistors. After a fixed-time off to allow the transistors to settle and the feed-back voltage to dissipate, the bridge again turns on and current builds up in the winding until the voltage across the sense-resistor again trips the comparator. The digital phase-input (F) level (HI or LO) selects which pair turns on and corresponds to the direction of current flow through the winding. The current controls, (I0 and I1) select one of four comparators; zero, low, medium, or full. The output is therefore a series of current pulses equal in amplitude and separated by the period of fixed time off. The value of the current sense resistor is pre-selected to produce a current amplitude equal to that of the current rating of the motor winding. If I0 and I1 select a comparator other that FULL, then the sense resistor feed-back voltage trips at less than full current. The reference voltage of the comparators is also available as an input to the device. By externally controlling this reference input, the output current can be varied between zero and full (i.e. microstepping).

The driver card contains three sections: (1) the step generator, which controls the levels of the phase; (2) the drivers; and (3) the Auto-Park which controls the output current automatically. The step generator is a counter-PROM configured as a four-eight-sixteen-thirty two step counter. The outputs of the counter control the phase inputs of the driver IC. Each step-clock causes the step counter to toggle one step and decode a pair of phase commands to the driver which cause a winding current direction change resulting in a one step rotation of the motor. The direction input, input directly to the counter, directs the decode to produce a CW or CCW rotation sequence.

WIN\PLC\MS2PLCL2.BMP

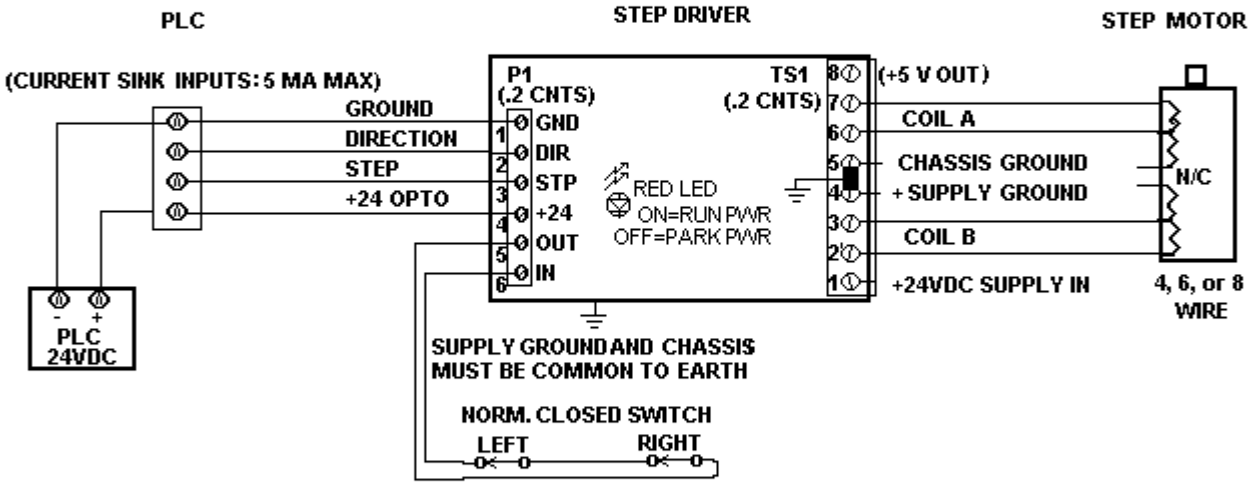
MM 2.5 STEP MOTOR TRANSLATOR/DRIVER WITH +24 PLC INTERFACE

(FOR USE WITH DC SINKING OUTPUTS ONLY)

PLC INTERFACE WIRING DIAGRAM

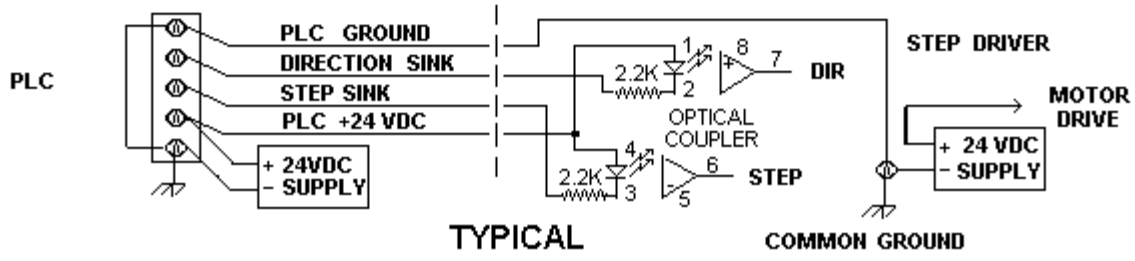
CAUTION ! OPTICALLY ISOLATED DEVICE. CONNECT ONLY AS SHOWN !
NOTE ! ALL GROUNDS ARE COMMON ; INCLUDING DRIVER MOUNTING HOLES
P1 AND TS1 ARE EURO STYLE SCREW-TERMINAL STRIPS

MODEL# MM 2.5 FQHM SINK +24 (TYPICAL)



LIMIT LOOP SAFETY (OUT OF BOUNDS)
DO NOT CONNECT TO ANY PLC TERMINAL

+24 VDC CURRENT SINK TO DRIVER OPTO INTERFACE



INSTALLATION AND OPERATION

Before operating the MM series, verify that the step angle jumpers are correctly installed for the desired mode of operation and that the input connections are correct for optic isolation or direct TTL models. The configuration of the MM series requires attention to four areas: step size jumpers, power supply voltage, motor winding connection, and current control dial-pot setting. Refer to driver label for maximum current and voltage limits of the particular model. Refer to the Appendix section in the rear of this manual for details.

(1) POWER SUPPLY & MOTOR CONNECTIONS

Signal Name	Terminal Strip TS1	Data Connector P1
VMM	TS1-1	none

In general, the MM series requires an unregulated source of D.C. voltage connected to VMM. The current output must equal 1.414 the full rating of one motor winding. The voltage can be between 12 and 40 volts D.C. (maximum). The higher voltage is required only for higher step rates. In general, do not use a regulated power supply as performance is reduced. Refer to the unit label for the VMM maximum of that model.

VCC	TS1-8	none

The +5vdc TTL supply is installed on opto isolation models. TS-8 is a test point only.

GND	TS1-4 & 5	P1-1

In all cases, ground is COMMON to all grounds; digital VCC, analog VMM, chassis ground and green wire ground (AC power ground). If a dual (VMM & VCC) supply is used, then an identical and equal ground lead is connected; 2 each wires to TS1-4 and 5. Always bridge the supply returns and connect to chassis. If separate supplies are used, connect the VMM supply and ground to the TS1 connector. In all cases, connect chassis ground (green wire ground or earth) to the driver or supply grounds.

COIL-A/COIL-B	TS1-2 & 3, TS1-6 & 7	none

A pair of motor windings are connected across each coil connection. Bipolar motors have FOUR leads (two pair). Unipolar motors with SIX leads can be used provided a coil end and a center tap are connected (unused wires MUST be INSULATED and cut off or tied back). NEVER attempt to connect the center taps of unipolar motors to VMM, except in the case of FIVE wire motors. NEVER insert dropping resistors in the power supply leads or winding leads. NEVER insert caps or coil filters across the windings. Refer to Appendix D for Motor Wiring Schemes.

(2) INPUT SIGNALS

Direction Input (DIR) P1- 2
The optically isolated direction (+12 to 25vdc sink compatible) inputs to the direction pin of a counter. A series resistor (2.2k) is installed in the direction input. Setting direction HI or LO reverses the direction of motor rotation. Motor rotation with respect to the state of the direction input may be reversed by reversing the motor winding pairs.

Step Input (CLK) P1- 3
The optically isolated step-clock (+12 to 25vdc sink compatible) inputs to the clock pin of a counter. The counter toggles on a LO to HI transition. The Step CLK MUST be normally HI (+24vdc) and go LO only long enough to toggle th counter (100us to 1ms). A series resistor (2.2k) is installed in the step clock input.

Opto Supply (+12 to +24 vdc) P1- 4
Power for the high side of the optical isolation gates.For testing only; normally not connected. The current control function shifts the output current to the motor coils between 100% of the Current Adjust power setting and park power. When PRK is HI (+5vdc), the unit produces FULL power. If PRK is LO (0vdc), the unit outputs at PARK (40%) power. On units so equipped, PARK power may be preset at the medium (50%) power level. PARK condition is used to reduce power supply requirements and motor dissipation during non-step periods. Any load which can be moved by the motor at full power can be firmly PARKed at low power. The motor will free-wheel only if the ABORT (ABR) line is HI.

Abort Loop Pins P1- 5 & P1- 6
These pins normally constitute the ABoRt Loop Safety (limits) System. The ABR inputs must be closed to step. If the inputs are disconnected, the driver control output will output zero current. NOTE: the driver is not OFF, power is still being regulated to the zero condition. The motor will free-wheel. ABORT is normally only used in stand-by (position loss may occur), in series with safety switches (limits) or other emergency stop conditions. Note that the ABR inputs are NOT isolated and must be connected to isolated contacts only! Never connect these signals to any potential or device except passive switches or relays.

(4) FULL/HALF/QUARTER/OCTAL STEP SELECT
This series will operate either in FULL/HALF/QUAD/OCTAL. The select pins to be selected either HI or LO with the dip-clip jumpers. The jumper pins are located next to the P1 connector. Both jumpers must be installed or driver will malfunction.

(5) CURRENT CONTROL DIAL
The current dial sets the 100% power level of the driver outputs as required. Refer to App C.

(7) CURRENT SENSE RESISTORS SA, SB
The current sense resistors are factory installed to reflect the highest current of the driver model. To select the correct resistor value for the desired current, divide 400mv (the trip point of the driver current comparator referenced to 5 volts) by the rated current, i.e. Rs = 400mv/Imotor coil. For example, a 1 amp motor requires a 0.4 ohm resistor. In general, always consult the manufacturer before modifying the driver. NOTE: High levels of current (full power park or constant low speed stepping) may cause the driver chip's overtemp limit sensors to cut back the output to a safe (cooler) level resulting in reduced power and erratic stepping. NEVER add additional resistance in series with the motor windings or add caps across them. NEVER connect the center taps of SIX WIRE (unipolar) motors to VMM (see Appendix D). NEVER confuse the sense or feedback resistors (SA,SB) with "dropping resistors" which are NOT used in constant-current, bipolar drivers like the MM series. Always simply call the Service Center if there are questions about the operation of the units.

APPENDIX C: MOTOR CURRENT ADJUSTMENT MM 2.0 (2 AMP MAX) SERIES

TO SET CURRENT; ALIGN SLOT TO MARK; CAREFULLY.
POT ADJUSTS PERCENTAGE OF MAX POWER . 2 AMP x 50 % = 1 AMP /COIL

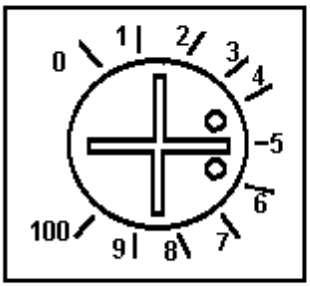
IN GENERAL:

CURRENT TOO LOW; MOTOR SLIP FROM REDUCED TORQUE
CURRENT CORRECT; SMOOTH ROTATION WITH NO SLIP OR RESONANCE
CURRENT TOO HIGH; EXCESSIVE NOISE, SLIP, MOTOR OVERHEATING
(ABOVE 85 C), AND POOR RAMP PERFORMANCE

BOARD EDGE →

PERCENTAGE OF MAXIMUM POWER →

MIN



MAX

NOTE:
DRIVER WILL REDUCE CURRENT IF OPERATED CONTINUOUSLY AT SLOW RATES (200 PPS) WITH CURRENT SET ABOVE 60 %.

WARNING: CONSTANT CURRENT, AUTO-PARKING, BI-POLAR DRIVERS !
DO NOT ATTEMPT TO MEASURE CURRENT WITHOUT SPECIAL INSTRUCTION

APPENDIX D MOTOR WIRING SCHEMES PAGE 1/2

Performance of a stepper motor based system depends more on the electronic drivers used than it does on the motor itself. A step motor (both PM and Hybrid type) is made to step by sequencing the orientations of the Magnetic fields in two coils. The UNIPOLAR drive method of is illustrated, in the figure, using just ONE coil of the motor. Note that the center tap of the coil is connected to the positive motor supply voltage. An electronic circuit, represented by the switch, then connects one end or the other to ground for current to flow from the center tap to the grounded end. The most significant factor is that only one-half of the coil is used at any given time and that the magnetic field intensity (motor torque) is proportional to the product of the number of turns in the coil and the current passing through the coil.

Motors designed for BIPOLAR drivers will often have only four leads. However some manufactures will provide the motors in 8 wire versions to offer a performance choice for bipolar drive users as in figures C & D. Four lead bipolar motors may use larger wire, since only half the windings are required in the given space of the motor body. The paralleling in figure C is the equivalent of this to achieve lower winding resistance and thereby doubling motor efficiency. The other alternative for the motor designers is to use a greater number of turns in the winding space. This is shown by figures B & D and results in more torque with a lower coil current but a subsequent loss of high speed torque.

Although step motors are often classified as bipolar or unipolar (2 phase or 4 phase), these terms are more accurately applied to the types of electronic circuit used to drive the motor. Bipolar drivers can drive 4,5,6 and 8 wire motors. When the motor is described as unipolar, the specifications are presented with the assumption that the motor will be driven with a unipolar drive. Therefore the specifications must be translated to bipolar when the motor is used with a bipolar driver. In general, the translation is similar to a unipolar driver with dropping resistors in series with the center taps; referred to as L over x R with R equal to the motor winding resistance. For example, a L over 4R unipolar driver has a resistor equal to 4 times the winding resistance. In bipolar, the L over R ratio is the ratio of the motor voltage to the supply voltage. A L over 4R bipolar drive, for example, would be a 6 volt motor and a 24 volt power supply. Performance would be similar to the L/4R torque curve of a unipolar motor. The figures identify the various connection options when using a bipolar driver with 6 or 8 wire motors.

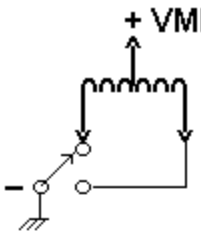
A: SINGLE COILS. Identical to unipolar specification (if the supply voltage equals the specified motor voltage). Normal connection of a bipolar driver to 6 wire motor.
B & D: SERIES COILS. This configuration will produce torque greater than the unipolar specification indicates. To stay within the power (wattage) rating of the motor, reduce the unipolar specified current by 30%; depending on the duty-cycle of the system (park time). Note that the torque curve of this configuration is considerably fore-shortened as this motor is now the same as a motor with a rating of twice the voltage (slower motor).
C: PARALLEL COILS. When this configuration is driven at the unipolar current, the motor will perform identical to the specification but the motor will dissipate only one-half the power (it is twice as efficient). When the current is increased by 1.414, to drive the motor at it"s full power rating, the motor torque is increased by approximately 60% Note that this torque curve is extended by four times (high speed system).

Resonance (vibration) of a step motion system depends on the speed and power range of the motor. Fast windings (A & C) are "quicker" and may break into resonance easier than slow (B & D). Power windings (B & D) may deliver "excessive" power (torque) to the system and produce resonance. In general, resonance indicates, except at the low (100 sps) and mid-frequency (1000 sps) bands, excessive power; therefore reduce the driver current for smoother operation or wire the motor for "softer" response.

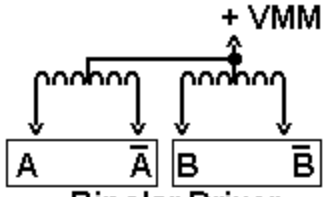
NOTES: If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SID / SMD driver boxes, pins 1 & 3 or $ & 6.

Five wire motors are really 6 wire motors with the center tap common. The center tap must be connected to the motor supply voltage. If phases 1, 2, 3 or 4 are crossed, motor will not rotate (hums). For MS cards, pin 1 is VMM, for SID /SMD (if connected), pin 5 is VMM and pin 2 is GND.

Systems with pin 5 & 2 connected are used to power external relays or solinoid valves. The pins are keyed (reversed). Never attempt to connect any motor leads to pin 2 and only 5 wire center taps to pin 5. Pins 2 & 5 are normally not connected and used to store the unused leads of 6 or 8 wire motors.

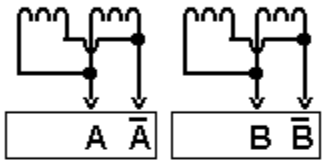


Typical Motor Winding
Unipolar Drive
[only 1/2 motor shown]



Bipolar Driver
5 Wire Motor
Coils in Series Only
[speed & torque = Fig. A]

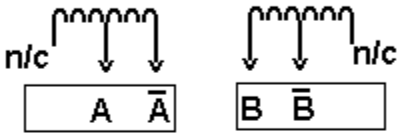
8 Wire - Parallel Coils



Best Speed - Best Torque

Fig. C

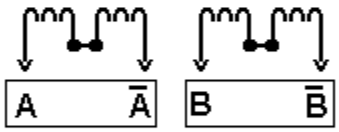
6 Wire - Single Coils



Normal Speed & Torque

Fig. A

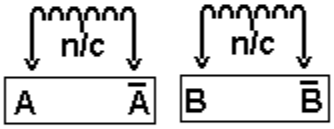
8 Wire - Series Coils



Low Speed - High Torque

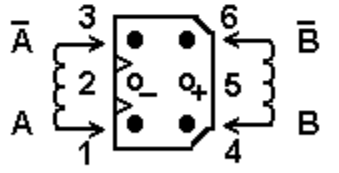
Fig. D

6 Wire - Series Coils

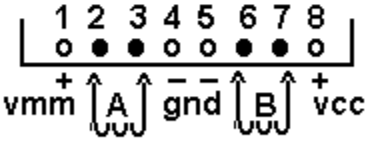


Low Speed - High Torque

Fig. B



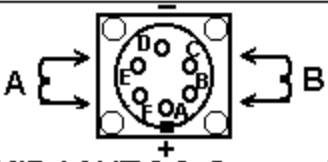
SMD / SID 2/4 Connector



MS/MM Card Connector

MOTION GROUP MOTOR CONNECTORS

SMD / SID HD Connector



MID / ANT 2.0 Connector

SPECIFICATIONS - MM 2.5

PARAMETER		MIN	MAX	UNIT
Power				
Motor supply voltage		12	40	VDC
Current (no motor)		150	160	ma
PWM frequency				
MD10A	18	24	Khz	
Motor current				
MS2.5		0.05	2.5	Amp
Step pulse input				
Voltage		0	+5.0	VDC
Sink surrent		12	20	ma
Pulse high		1		uSec
Pulse low		1		uSec
Rise time			0.5	uSec
Fall time			0.5	uSec
Frequency			500	KHz
Logic ' 1' volts		+1.8	+2.0	VDC
Direction input				
Voltage		0	+5.0	VDC
Sink current		12	20	ma
Logic ' 1' volts		+1.8	+2.0	VDC

Note: The step pulse input must be a logic 1 (high) during direction input change.

Environmental			
Operating temperature	-20	+50	C
Humidity (non-condensing)	0	95	%
Shock		100	G
Altitude		30.000	FT
Mechanical			
Weight	0.3 lb		
Dimensions	2.5" x 2.5" x 1.0" Typ.		
Mounting hole centers	2.3" x 2.3"		
Mounting hole size	1/8" Dia.		

THE MOTION GROUP
SERVICE CENTER
800-424-STEP
motiongroup.com
PO BOX 669 CLOVIS, CA 93613-0669 TEL: 559-325-2727 FAX: 559-325-7117

PURCHASE AGREEMENT

Purchase of any item from THE MOTION GROUP represents a agreement between THE MOTION GROUP and the customer. Therefore the customer agrees that all information contained in the included documentation, drawings, and software is the exclusive property of THE MOTION GROUP and that the customer is bound to prevent dissemination of this information to unauthorized parties.

The above mentioned information represents the "Intellectual Property" of THE MOTION GROUP and is thereby protected by the Copywrite Act of 1988. In particular, the firmware tables, artworks, and design drawings are specifically copywrite protected.

Also included under Trademark protection are the following:
MINI-STEP QUAD-STEP AUTO-PARK DIAL-POT MMA PRINTER PORT DRIVER

THE MOTION GROUP information is transfered to the customer for their own uses upon the purchase of a TECHNOLOGY TRANSFER AGREEMENT and is limited to those items listed in the agreement. Contact the Customer Service Center for TTA details.

All equipment purchased from THE MOTION GROUP includes a 100 % warranty for parts and labor. This warranty may be revoked at any time and the purchase refunded at the discretion of THE MOTION GROUP.