mmman.wri 9-95

MM 2.0

Mini-Step^{tm} Translator / Driver Card

OPERATION AND INSTALLATION

MANUAL

FOR MM SERIES

THE MOTION GROUP
SERVICE CENTER
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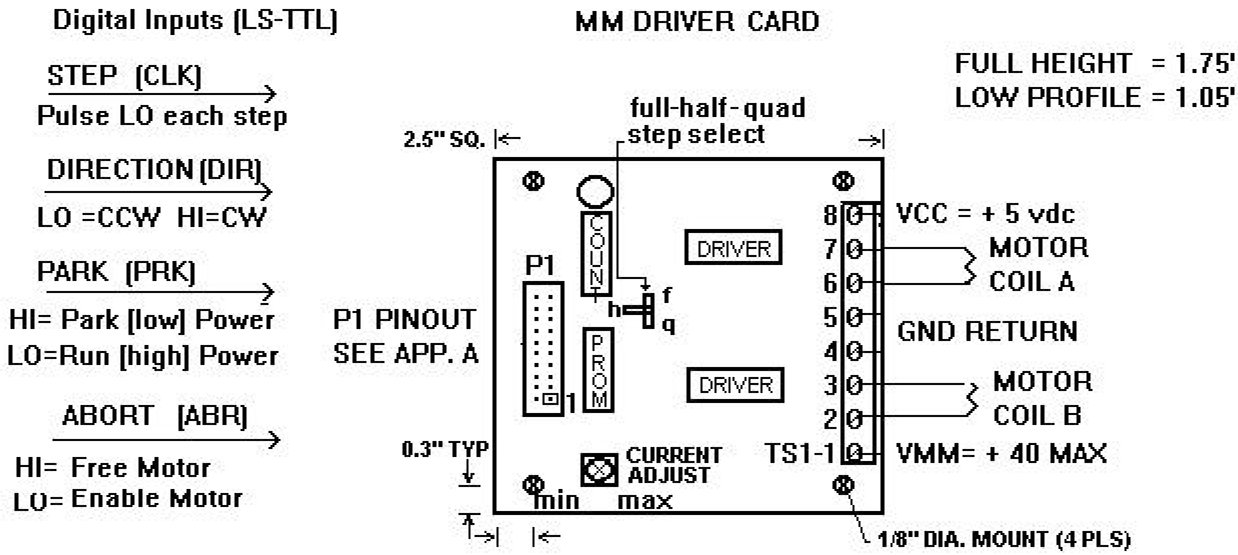
MM 2.0 STEP MOTOR TRANSLATOR/DRIVER
2 AMPS PER COIL IN FULL, HALF, OR QUAD STEP



PROM CODES

QD: Quarter Step only
FH: Full or Half Step
HL: Park Power Shift 100% to 25 %
HM: Park Power Shift 100% to 50 %

POWER SUPPLY
REQUIREMENTS:

VCC = + 5 vdc TTL Logic
@ 100 ma

VMM = +6 to 40 vdc
Motor @ 1.4 x coil amps

PRODUCT DESCRIPTION

The MM, Series 1 & 2, 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 four input signals: (1) the step pulse - STP, (2) the direction level - DIR, (3) the power level - PRK, and 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. In addition to the step and direction inputs, the driver will accept an output power control input. This digital input, PARK, controls the amount of current delivered to the motor windings either run power or park power. If the signal is HI or floating, the driver is at reduced current; if LO the driver is at full current. 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 MS 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 driver also requires +5 TTL logic supply for the digital sections.

OPERATIONAL MODES

The driver can be operated in three modes: FULL-step or HALF- step, and QUAD-step only. In each of these modes, the output power control, PRK, must be controlled by an external device (microprocessor). PRK 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 digital levels of the phase (F) inputs; (2) the drivers; and (3) the Auto-Park gate, which if installed, controls the output-current digital input, PRK, automatically. The step generator is a counter-PROM configured as a four-eight- sixteen step counter. The outputs of the counter are combined through PROM gates into two outputs which control the phase inputs (F) of the two driver IC's. Each step-clock causes the step counter to toggle one step and the PROM decodes a pair of phase commands to the drivers 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.

INSTALLATION AND OPERATION

Before operating the MS & MM series, verify that the jumpers are correctly installed for the desired mode of operation and that the input connections are correct for that mode. Locations of jumpers and signals are identified on the bottom side of the unit circuit board. The configuration of the MM series requires attention to four areas: step size jumper and PROM type, 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	P1-13 & 14, 1

If the optional +5vdc TTL supply is not installed, then an external 150ma digital supply is connected to the TS1-8 VCC connections. TS1-5 is provided for ground return. TS1-8 is protected by a 6.8vdc TRANSORB. The VCC is ALSO common through the digital control connector P1-13 & 14. The +5vdc can be furnished by: (1) the computer or controller power supply only, or both. If the system power is not controlled by one switch, always isolate the driver systems with a diode in the VCC connection. In any case, controller VCC and driver VCC MUST BE COMMON or other interface connections are required (opto isolation).

GND	TS1-4 & 5	P1-19, 3

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. Connect the driver VCC (P1-13&14) and ground (P1-19) from the driver to the controller bus. Connect the VCC supply to the controller bus. IN ALL CASES, ANY VCC BETWEEN THE CONTROLLER AND IN THE DRIVER MUST BE COMMON OR ELSE OPTICAL ISOLATION IS REQUIRED. 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 Digital Inputs P1-12/20 & 11/19 See Appendix A

Step Input (CLK) P1- 15
The step-clock (+5vdc TTL compatible) inputs to the clock pin of a 74191-type counter. The 74191 toggles on a LO to HI transition. The Step CLK MUST be normally HI (+5vdc) and go LO only long enough to toggle th counter (100us to 1ms). Refer to TTL data books for max/min clock conditions. A pull-up resistor (4.7k) is installed on the step clock input.

Direction Input (DIR) P1- 17
The direction level inputs to the 74191 counter. The input is pulled up by a 4.7k resistor. Setting the input 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.

Current Control Input (PRK) P1- 11
The current control signal shifts the output current to the motor coils between 100% of the Current Adjust power setting and park power. When PRK is LO (0vdc), the unit produces FULL power. If PRK is HI (+5vdc) or floating, the units outputs at PARK (25%) 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.

The PRK control input must be directly driven by a single data bit or optional signal (Device Select or Motion Complete are typical signals from motor controller ports).

Abort Control Input (ABR) **P1- 9 (see next)**
The ABR input must be LO to step. If the input is HI or 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.

Other Signals (CPU ABR and HOME) **P1- 10,12 & P1- 4,16**
Pin 12 is the normal input to P1- 9 when the ABoRt Loop is used.
Pin 4, 16 is the output signal HOME back to the controlling device.

Spare Inputs **P1- 18,8 & P1- 20,7**
Pins 18 and 20 can be used for other signals to/from the card. See Chassis Signals connector. Pin 20 is normally keyed on free standing cards.

(3) Chassis Signals **P1- 1 to 9 & P1- 2 to 10**
These signals are normally used to provide for a convenient method of cabling the driver between the controller and the motor, power supply, chassis assemblies.

Home Sensor Pins **P1- 1, 2, 3, 4**
These pins power the optical home sensor circuit. SEE APPENDIX A & F. Pin 1 is VCC +5 power, pin 2 is VLED power, pin 3 is GND (ground), and pin 4 is the HOME input from the sensor.

Abort Loop Pins **P1- 9 & P1- 10**
These pins normally constitute the ABoRt Loop Safety (limits) System. The driver enable is output from the controller to pin 12 (CPU ABR) and output to the loop from pin 10 (to limit loop) and returned from the loop to pin 9 (ABR). The ABR loop is NORMALLY CLOSED; opening the loop for any reason FREEs the motors. Never connect these signals to any potential or device except passive switches or relays. Door locks and other safety switches may be inserted in the loop. See Appendix B.

Spare Pins **P1- 6, 5, 7, 8**
These pins are used as required to provide VCC (pin 6) and GND (pin 5) to the chassis system. Pins 7 and 8 are user pins which are generally jumped as required to the spare pins on the data connector. See Appendix A.

(4) FULL/HALF/QUARTER STEP SELECT
This series will operate either in FULL/HALF step or QUARTER step only mode. FULL/HALF requires the FH PROM to be installed and the mode pin to be jumped either FULL or HALF with a dip-clip jumper. The jumper pins are located next to the top of the PROM socket. See Appendix F. In QUAD step mode, the QD PROM is installed and the mode pin is jumped to the QUAD pin. Conversion is a field operation.

The PROMS are also labeled with the current control selection.

HL: shifts power HIGH (100%) to LOW (25%) during parking.
HM: shifts power HIGH (100%) to MED (60%) during parking.

(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.

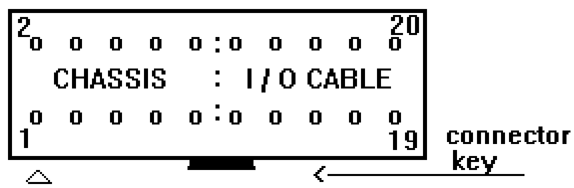
APPENDIX A: CI CABLE DIAGRAM FOR MM SERIES CARDS

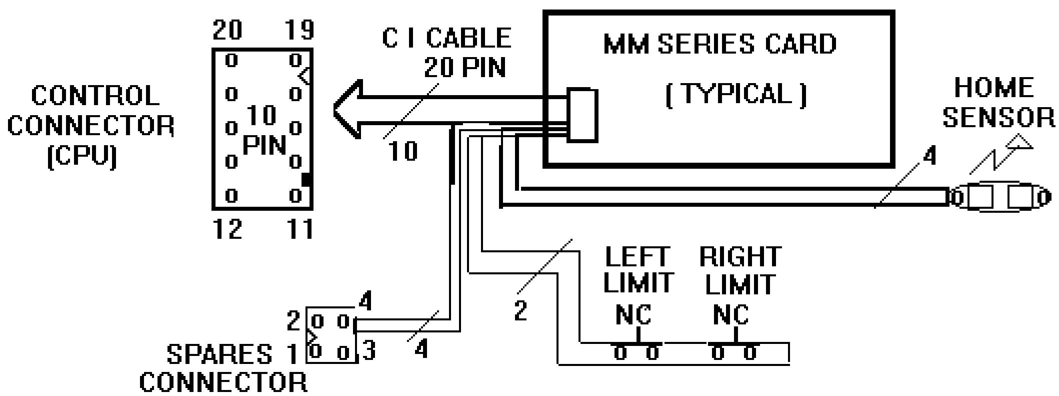
COLOR [ ] = MOLEX PIN #

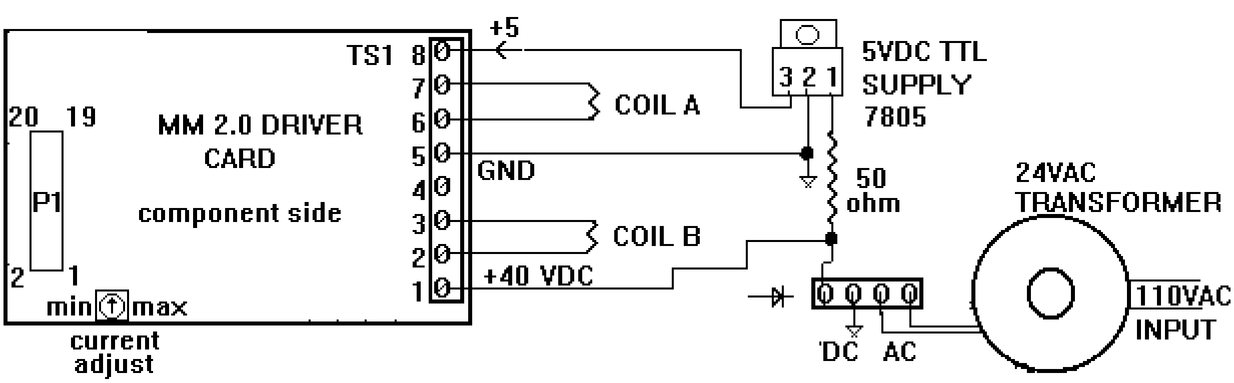
1: SENSOR +5 VDC	BLK [1]	2: SENSOR LED ANODE +	WHT [2]
3: SENSOR / LED GND	GRY [3]	4: SENSOR (home sensor)	PUR [4]
5: USER SPARE	BLU [1]	6: USER SPARE	GRN [2]
7: USER SPARE	YEL [3]	8: USER SPARE	ORN [4]
9: ABR (from limit loop)	RED [1]	10: CPU ABR (to limit loop)	BRN [2]
11: PRK (power select)	BLK	* 12: CPU ABR (from cpu)	WHT
13: +5 VDC (cpu)	GRY	14: +5 VDC (cpu)	PUR
15: CLK (step pulse)	BLU	* 16: SENSOR (to cpu)	GRN
17: DIR (direction)	YEL	18: SPARE	ORN
19: GROUND (cpu)	RED	20: SPARE	BRN

* TRACE JUMPER

P1 CONNECTOR
20 PIN







APPENDIX B: DESCRIPTION OF HOMING AND ABORT LOOP PAGE 1/2

HOMING. A major advantage of a digital Open-Loop step system is the ability to operate plus or minus zero steps (no error). Two conditions are required. One is that the motor is sufficient for the load in normal operation and second, that a reference position, commonly called the "home position", be consistently established during initialization of the system. When step motors are rotated by counting (clocking) out a number of steps, in theory, the motion will take place +/- zero steps. The exact mechanical position of the motor can vary by the motor step accuracy; typically +/- 3 % of one step (non-cumlative). A proof of +/- zero step operation is, first, to reference a starting positon of the motor or "home". During homing, the motor is stepped backwards into a switch, reversed, and then stepped forward until the switch opens. The point of interest is not the exact mechanical position but rather on which step the switch changed state. For that reason, only high resolution "PHOTO-LOGIC" optical-beam switches are used in TMG systems.

SLIP-DETECTION. After the motor is home, the controller position counter is reset to the home position, typically position 1 (one step out of the sensor). The motor is then stepped CW to any position. To slip-detect the system, the motor is returned to position 1. If the sensor remains open, then the motor is stepped to positon 0. If the sensor closes, the system is operating +/- zero steps (error free). Note that a single step lost (slip) will always result in at least a movement of 4 full steps away from the correct position. Open loop systems are slip-detected at regular intervals to prove continuing slip-free operation.

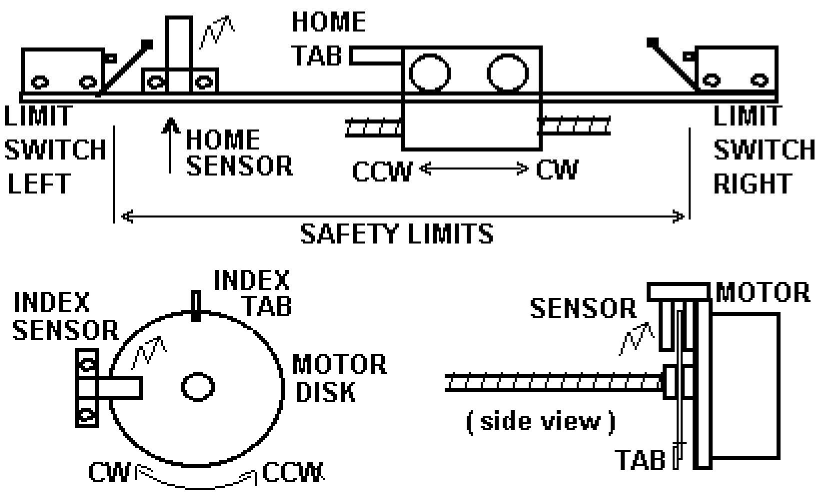
CENTER HOME AND CONTIGUOUS SLIP DETECTION. If the home sensor is located at the center of axis motion and a step bar is mounted along the entire motion path, then the home position can be verified each time the system crosses the center line. A stepped bar is thin strip with a left high side and a right low side. The high to low edge is the center line.

LASH COMPENSATION. A major advantage of steppers is in their "repeatability" which is typically less than .01 % because the digital controls are not affected by temperature, aging, voltage or adjustment. This allows errors such as lash and distortion to be zeroed-out.

Lash compensation adds or subtracts steps, at each change of direction or because of other forces, to take-up the lash error. Lash compensation is accomplished during the slip-detection process. When the system is slip-detected the first time, the sensor will not close at position 0 because of the lash; home LED remains off. At this point, the system is single-stepped CCW until the sensor closes; home LED is on. The number of CCW steps is the lash compensation value. The system is re-homed and the counter loaded with this value (see At home command). The motor is then moved some number of steps CW, returned to position 1 (sensor open), and finally position 0 (sensor closed). The system is +/- zero steps.

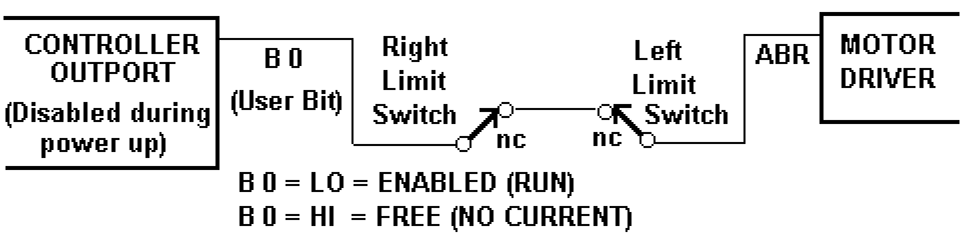
Screw distortion error occurs when the screw pitch, which is so many turns per inch, does not move the correct distance after the correct number of turns of the motor. For example, a 10 turn screw should cause linear travel of 1 inch every 2000 steps (200 step/rev motor). If, rather than commanding the motor controller to go in 2000 step increments, the controller moves to absolute positions such as 2000, 4001, 6003, 7999, ect.; the error is eliminated.

SUPER HOMING. In high resolution systems, two sensors are used. The first sensor, the home sensor, is mounted to the motion platform in the typical configuration. The second sensor, the index sensor, is located as an index detector on the motor shaft. The index can be either a disk with a tab or a long pin. During the homing operation, the motor is stepped backwards until the first sensor is blocked. The motor, however, continues to rotate until the second or index mark is detected. The system is now "homed to the step". TMG systems with Super-Homing use two identical "PHOTO-LOGIC" sensors wire-ORed together so that both must be blocked before the home signal is detected. The H or home command of the motion controller will operate with either single or double sensors.



ABORT LOOP FUNCTION. In TMG systems, the ABORT loop is used to remove all winding power to the motor during an out-of-bounds condition. The ABORT feature can be used to provide hard-limits, emergency stop, door inter-locks, and other safety features. As the ABR input, to the driver, must be LO (ground) for the driver to step; opening the loop will stop (free) the motor regardless of the control logic. The diagram is typical of TMG "Fail-Safe, Hard-Soft" limit loops.

LIMIT LOOP WIRING DIAGRAM



NOTE: CONTRARY TO POPULAR PRACTICE, IT IS UNWISE AND UNSAFE TO SENSE LIMITS AND OTHER SAFETY CONDITIONS THROUGH THE COMPUTER INPUTS PORTS.

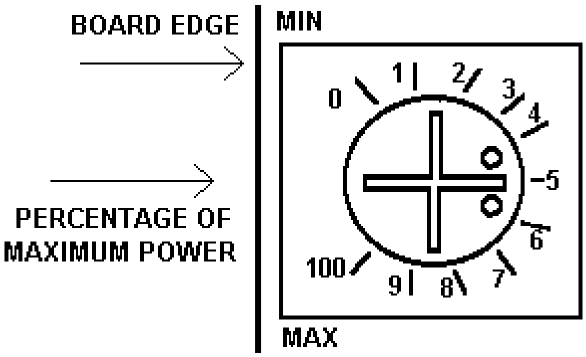
All motion products, regardless of their final intended form, should initially incorporate home sensors and slip-detection in order to prove correct positioning during product development.

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



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

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.

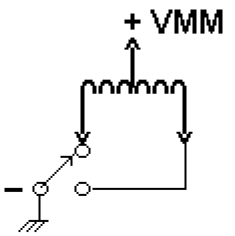
A: SINGLE COILS. Identical to unipolar specification (if the supply voltage equals the specified motor voltage). Normal connection of a bipolar driver to 6 wire motor.
B & D: SERIES COILS. This configuration will produce torque greater than the unipolar specification indicates. To stay within the power (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.

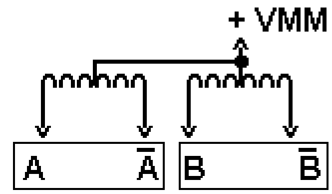
NOTES: If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SID / SMD driver boxes, pins 1 & 3 or $ & 6.

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.

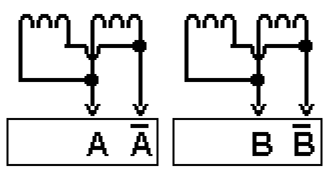


Typical Motor Winding
Unipolar Drive
[only 1/2 motor shown]



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

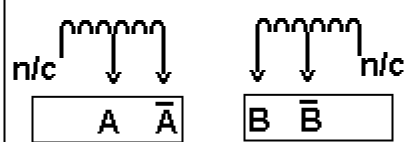
8 Wire - Parallel Coils



Best Speed - Best Torque

Fig. C

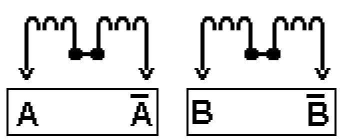
6 Wire - Single Coils



Normal Speed & Torque

Fig. A

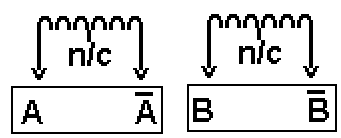
8 Wire - Series Coils



Low Speed - High Torque

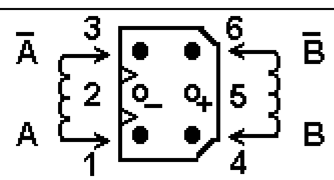
Fig. D

6 Wire - Series Coils

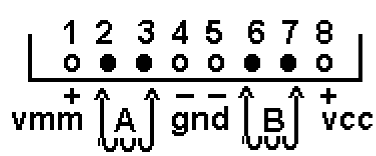


Low Speed - High Torque

Fig. B



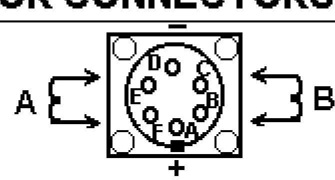
SMD / SID 2/4 Connector



MS/MM Card Connector

MOTION GROUP MOTOR CONNECTORS

SMD / SID HD Connector



MID / ANT 2.0 Connector

APPENDIX I PAGE 1/1

MOLEX - WALDOM NYLON CONNECTOR SYSTEM USED BY THE MOTION GROUP

The connectors used on Motion Group equipment are nylon connectors are manufactured by Molex and are refered to as .062 style (pin diameter) or .093 (large driver motors only). They are available from Newark, Allied, and Digi-Key and come in 1 to 36 positions with locking and mounting tabs which snap-in to punched holes on brackets or enclosures.

TYPICAL $	POLES	TYPE	PART #	NEWARK #	USED ON
5.84/10	4 (.062)	MALE HOOD	03-06-2041	31F1004	HOME SENSOR ASSEMBLY
5.95/10	4 (.062)	FEMALE RECT	03-06-1041	31F1005	HOME SENSOR CABLE
1.86/5	6 (.062)	MALE HOOD	03-06-2062	31F1008	STEP MOTOR ASSY
2.07/5	6 (.062)	FEMALE RECT	03-06-1061	31F1009	MOTOR OUTPUT
1.86/5	6 (.093)	MALE HOOD	03-06-2062	31F1008	STEP MOTOR ASSY
2.07/5	6 (.093)	FEMALE RECT	03-06-1061	31F1009	MOTOR OUTPUT

(Strain Relief Hoods are available on request)

Contacts for Connector Sets .062 SIZE

6.79	FEMALE SOCKETS	LARGE TAB	02-06-1103	31F1027	22-18 GUAGE WIRE
	MALE PINS	LARGE TAB	02-06-2103	31F1026	22-18 GUAGE WIRE
	FEMALE SOCKETS	SMALL TAB	02-06-1132	31F1029	30-22 GUAGE WIRE
	MALE PINS	SMALL TAB	02-06-2132	31F1028	30-22 GUAGE WIRE

Contacts for Connector Sets .093 SIZE

6.79	FEMALE SOCKETS	LARGE TAB	02-06-1103	31F1027	22-18 GUAGE WIRE
	MALE PINS	LARGE TAB	02-06-2103	31F1026	22-18 GUAGE WIRE
	FEMALE SOCKETS	SMALL TAB	02-06-1132	31F1029	30-22 GUAGE WIRE
	MALE PINS	SMALL TAB	02-06-2132	31F1028	30-22 GUAGE WIRE

In general, single wires use small tab contact; double wires the large tab

Tooling

105	RATCHET TOOL .062 DIA	HTR-2262 11-01-006	30F338	MAKES PERFECT CRIMPS	
105	RATCHET TOOL .093 DIA	HTR-XXXX	11-01-006 30F338	MAKES PERFECT CRIMPS	
13	HAND TOOL	HT-1921	11-01-0015	31F1049	REQUIRES PRACTICE
12	EXTRACTOR .062 DIA	HT-2285	11-03-0002	30F773	SPRING LOADED PUNCH-OUT
12	EXTRACTOR .093 DIA				

Nylon Connector Designer/Service Kit

Contains male/female housing assortment, hand crimper, pin extractor (not as easy to use as spring extractor; see above), contacts, and case.

40	DESIGNER KIT	.062	WM-072	30F774
40	DESIGNER KIT	.093		

All of the above, including custom cable sets are available from the factory.

Note: When disconnecting, grasp the mounting tabs, (not the wires) and rock from top to bottom (unseat the locking bump) rather than side to side and then pull the connection apart. The connections unseat easily with the right technique.

Contact factory for Heavy Duty Connectors with Metal Shells, Retainers, and Strain-Reliefs.

SPECIFICATIONS - MS and MM 2.0

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				
MS2.0		0.05	2.0	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	3 lb		
Dimensions	2" x 3.5" x 11.0"		
Mounting hole centers	2.625" x 8.250"		
Mounting screw size	# 6-32 x 1/2" max		

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