msman.wri 9-95

MS

MS - MiniStep translator /driver card

OPERATION AND INSTALLATION

MANUAL

FOR MS SERIES

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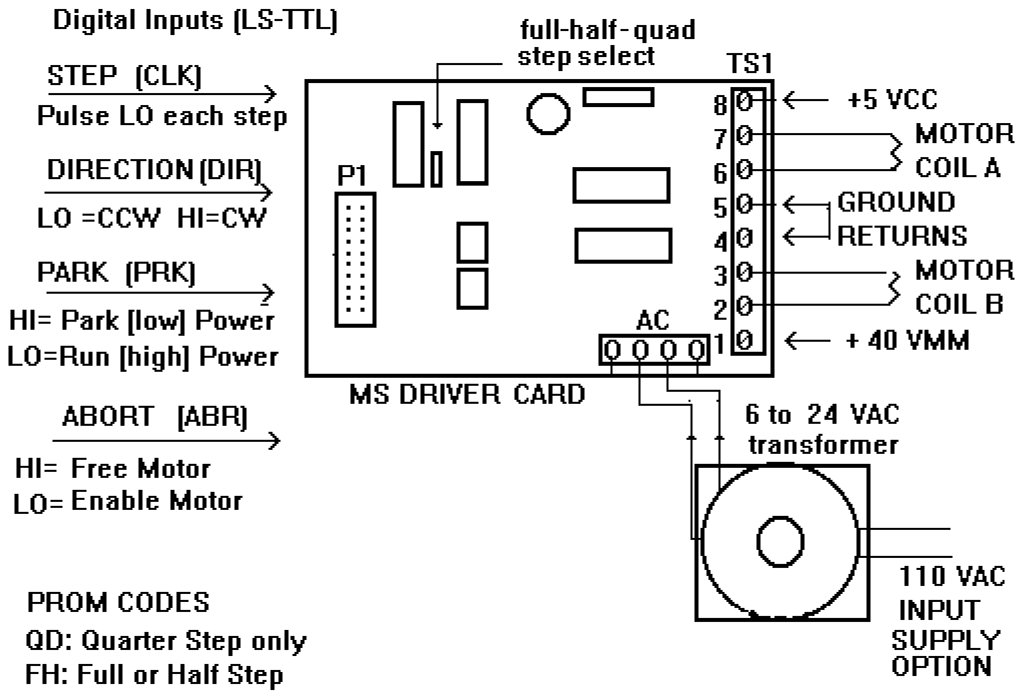
MS 2.0 STEP MOTOR TRANSLATOR/DRIVER
2 AMPS PER COIL IN FULL, HALF, OR QUAD STEP



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 %

See Appendix A for P1 connector
See Appendix B for Limit Loop
See Appendix C for Current Adjustment
See Appendix D for Motor connection
See Appendix E for Mechanical Card
See Appendix F for Home Sensor
See Appendix G for Opto Isolation Option
See Appendix H for AC Input Option

POWER SUPPLY
REQUIREMENTS:

VCC = + 5 vdc TTL Logic
@ 100 ma

VMM= + 5 to 40 vdc
@ 10 to 2000 ma

PRODUCT DESCRIPTION

The MM & MS, 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 MS 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, can be controlled: (1) by an external device (microprocessor); (2) internally by the AUTO-PARK option; or (3) by a hardwired configuration (not recommended). 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 he 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. Refer to the installation wiring diagrams found in the back of this manual. Locations of jumpers and signals are identified on the bottom side of the unit circuit board.

The configuration of the MS 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 MS 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 45 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, 6

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, 5

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. Refer to AUTO-PARK for additional requirements of the clock inputs.

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% power 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 power. On units so equipped, PARK power may be preset at the medium (MED) 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.

If the AUTO-PARK option is not installed, 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). The spare gate pad can be used as required to invert.

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- 10/12
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.

(6) SPARE GATES
The Spare Gate location is normally used for an option. The gates are used as required or: on-board timer, AUTO-PARK, Step Clk inversion, AD5 inversion, encoder decode chip and spare. Pull-ups are required on open-collector logic.

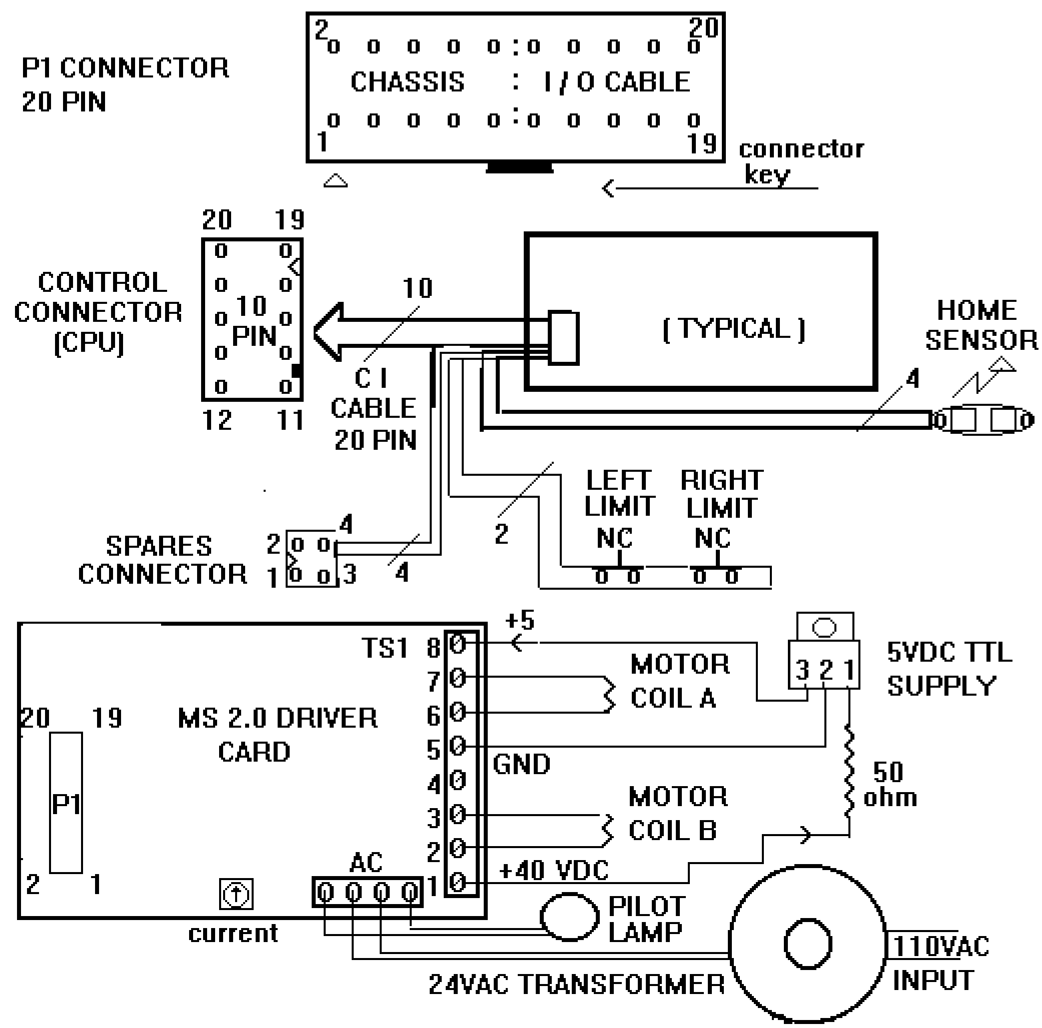
(7) CURRENT SENSE RESISTORS SA, SB

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 MS or MM series. Always simply call the Service Center if there are questions about the operation of the units.

APPENDIX A: CI CABLE DIAGRAM FOR MS SERIES CARDS

COLOR [ ] = MOLEX PIN # → = hard jumpers

→3 / 5: jumpered					
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 GROUND	BLU	1	6: USER + 5 VDC	GRN	2
7: KEY SPARE	YEL	3	8: 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 (same as 8)	ORN	
19: GROUND (cpu)	RED		20: KEY (same as 7)	BRN	

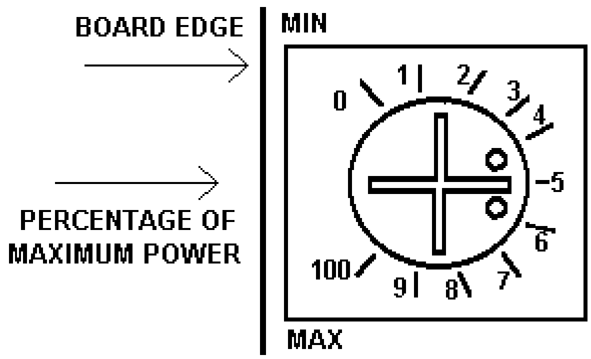


APPENDIX C: MOTOR CURRENT ADJUSTMENT MM 2.0 (2 AMP MAX) SERIES

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

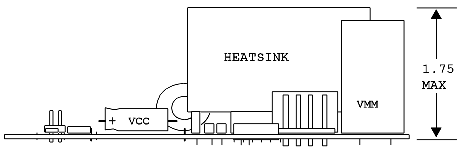


NOTE:
DRIVER WILL REDUCE CURRENT IF OPERATED CONTINUOUSLY AT SLOW RATES (200 PPS) WITH CURRENT SET ABOVE 60 %.

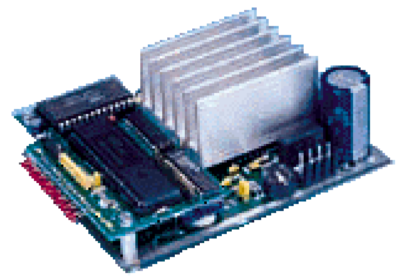
WARNING: CONSTANT CURRENT, AUTO-PARKING, BI-POLAR DRIVERS !
DO NOT ATTEMPT TO MEASURE CURRENT WITHOUT SPECIAL INSTRUCTION

MS 2.0 High Performance Stepper Motor Driver.

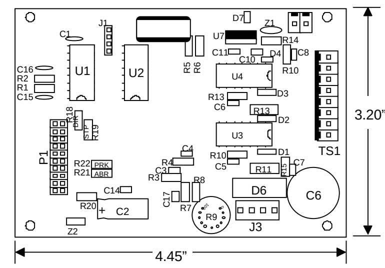
The **MS 2.0** is an extremely **powerful** stepper motor driver / translator unit capable of driving either bipolar or unipolar motors up to **2.0 amps per phase** in Full, Half or **Quad** step (3200 s/rev). The MS 2.0 requires only digital step pulses and direction signal (on board step sequences) and No step software required (onboard firmware). The MS 2.0 stepper motor driver features Switch-Mode Bipolar Constant-Current technology, **adjustable output current** and "**Auto-park**" which reduces motor dissipation during non-step periods. Fully compatible with matching TMG controller.



Compatible with standard stepper motors
(4,6 or 8 wire).



Shown with CY5.4 controller



TS1 Power & Motor pins

1. VMM IN (+5 - 40VDC @ 10 - 2000 ma)	2. +Coil A (Out)	3. -Coil A (Out)	4. GND
5. GND	6. +Coil B (Out)	7. -Coil B (Out)	8. VCC (+5VDC @ 100ma) IN

J3 AC Input pins

1. N/C	2. 6 - 24 VAC IN from transformer	3. 6 - 24 VAC IN from transformer	4. N/C

P1 Step motor control pins

CLK Input **STEP** pulse	P1-15	1 step per pulse when enabled
DIR Direction Set (Hi/Low)	P1-17	CW / CCW
Enable (ABR)	P1-9 ABR IN P1-10 ABR OUT P1-12 ABR from CPU	Jump P1-9 To P1-10 to Enable motor
Ground (GND)	P1-5 (User GND), P1-19 (CPU)	
+5 VDC	P1-1, P1-6, P1-13, P1-14	

P1 TMG Controller Interface pins

PARK	P1-11	Selects between Hi & Low Power
SENSOR	P1-2 P1-3 P1-4 P1-16	LED +Anode Led -GND Sensor signal IN Sensor to CPU
Spares	P1-7, P1-8, P1-18, P1-20	Unused pins

Electrical Specifications -

Input Voltage - Logic	+5 VDC (TTL)
Input Voltage - Motor	+12 to 40 VDC
Output Current (Adjustable)	0.05 to 2.0 Amps / Phase
Step Frequency	500 KHz Max
Step size	QUAD or Full/Half
Protection	Over-Temp, Over-Voltage, Over-Current
Current Reduction at standstill	Automatic: 0.5 sec after last step input. Selectable ratio.

Temperature

Operating	0 to +70 C
Storage	-40C to +125C
Mounting surface	0 to 70C

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