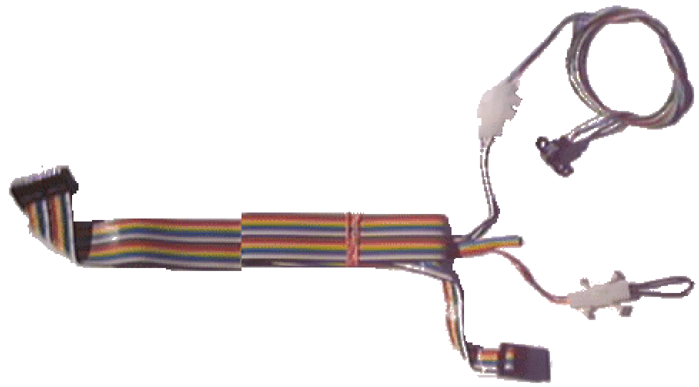
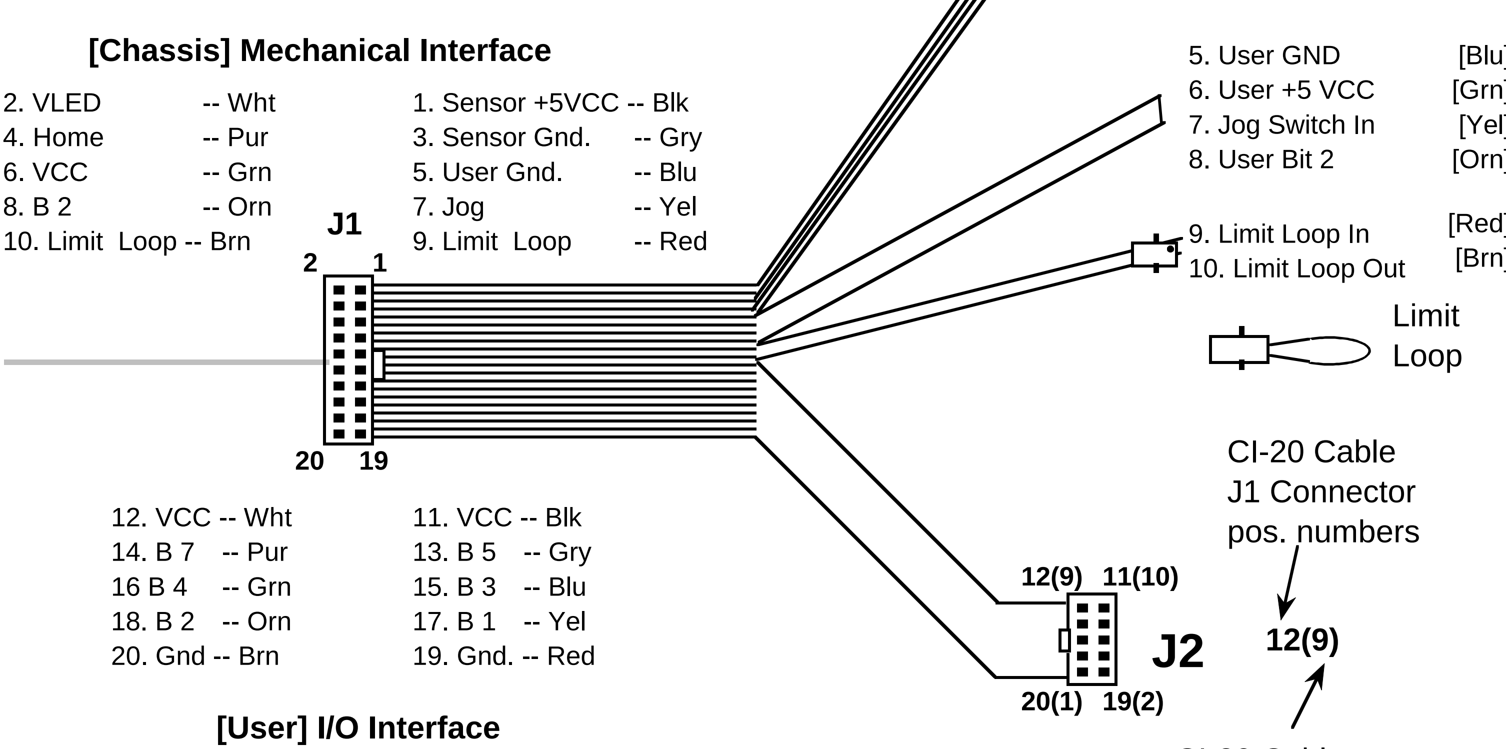
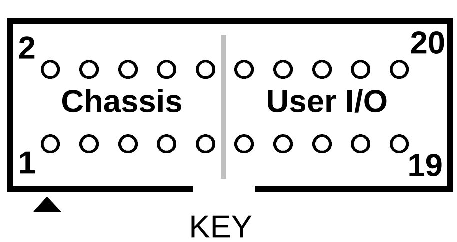
APPENDIX A: CI CABLE DIAGRAM FOR SID SYSTEMS





12 (9). VCC	Wht	11(10). VCC	Blk
14 (7). B 7	Pur	13 (8). B 5	Gry
16 (5) B 4	Grn	15 (6). B 3	Blu
18 (3). B 2	Orn	17 (4). B 1	Yel
20 (1). Gnd	Brn	19 (2). Gnd.	Red

P1 (CI20 Header)
SID Box Header Pin out

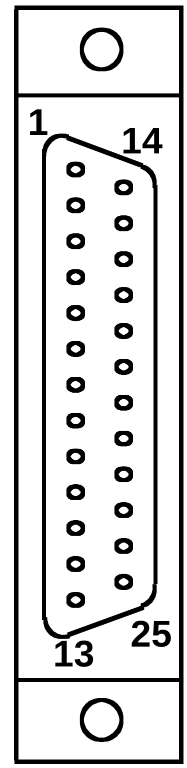


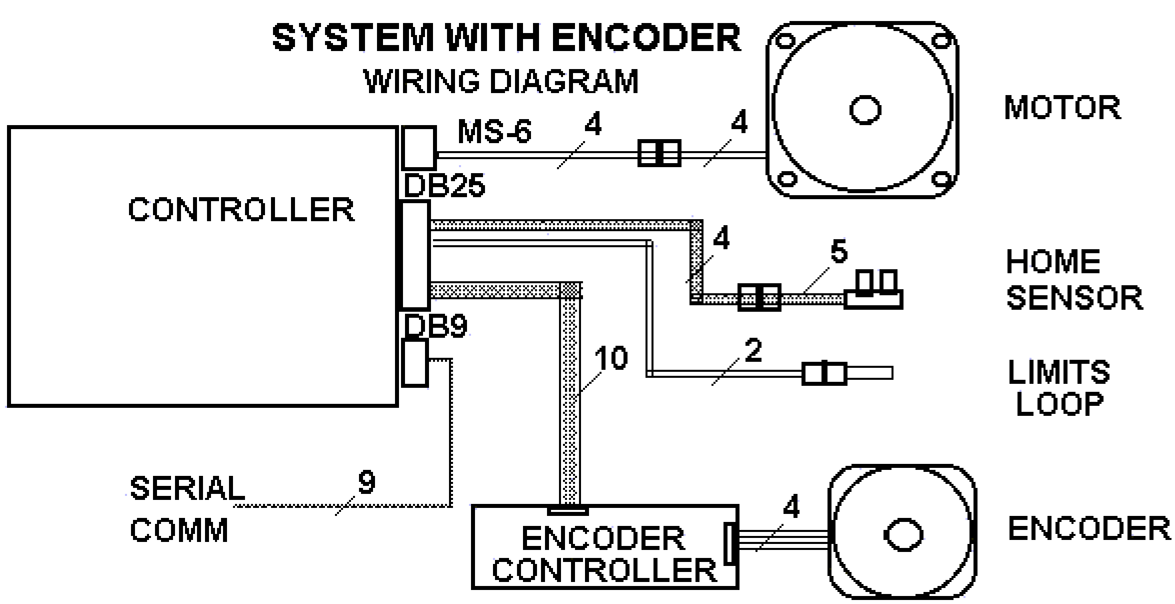
APPENDIX A: CI CABLE DIAGRAM FOR MID SYSTEMS

DB-25S CONNECTOR CABLING AND I/O CONNECTIONS

1		VLED	
	14	+5V	HOME
2		HOME	SENSOR
	15	GROUND	
3		+5V	
	16	GROUND	USER
4		B2	FUNCTION
	17	JOG	
5		CPU ABR [B0]	LIMIT
	18	DVR ABR	LOOP
6		I/O +5V	
	19	I/O +5V	
7		B7	
	20	B5	INPUT
8		B4	OUTPUT
	21	B3	FUNCTION
9		B2 SAME AS PIN	
	22	4	
10		B1 SAME AS PIN	
	23	2	
11		I/O GROUND	
	24	I/O GROUND	
12		SPARE	
	25	SPARE	
13		SPARE	
		SPARE	
		SPARE	

DB-25S





APPENDIX B: DESCRIPTION OF HOMING AND ABORT LOOP

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.

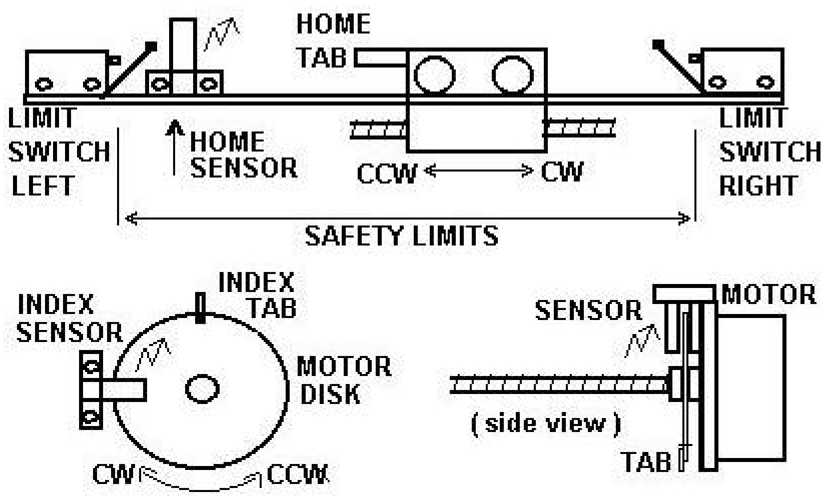
CENTER HOME AND CONTIGUOUS SLIP DETECTION. If the home sensor is located at the center of axis motion and a step bar is mounted along the entire motion path, then the home position can be verified each time the system crosses the center line. A stepped bar is thin strip with a left high side and a right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

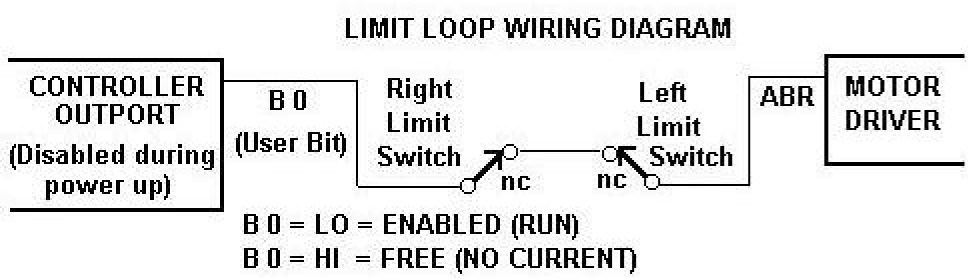
Lash compensation adds or subtracts steps, at each change of direction or because of other forces, to take-up the lash error. Lash compensation is accomplished during the slip-detection process. When the system is slip-detected the first time, the sensor will not close at position 0 because of the lash; 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. This technique requires a control system which carries a "map" with each individual machine. The EEPROM memory is suitable for this purpose.

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.



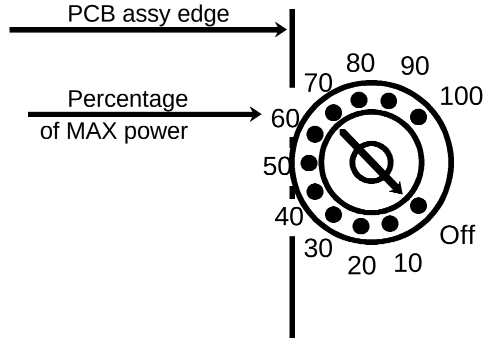
NOTE: CONTRARY TO POPULAR PRACTICE, IT IS UNWISE AND UNSAFE TO SENSE LIMITS AND OTHER SAFETY CONDITIONS THROUGH THE COMPUTER INPUTS PORTS.

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, particularly during software de-bugging. Typically, a test routine is established which passes slip-detection. Any detrimental modification or code flaw will be flagged by this routine.

APPENDIX C Adjustment For Current Control Pot

Set current adjust carefully; be as mechanically precise as possible. Align arrow to dot (as shown).
Pot adjusts percentage of maximun power. Ex: MS 2.0 x 50% = 1Amp/coil.

In General:	Current too Low:	Motor slip from reduced torque
	Current Correct:	Smooth motion with no slip or reasonance
	Current too High:	Excessive noise, slip and motor over-heating with poor ramp performance



NOTE: Driver will automatically reduce current (overtemp limits) if operated continuously at slow rates (<200 Full Steps/Sec.) or held stationary at full power and current settings above 60%.

WARNING: DO NOT operate motors above rated current (nameplate) Overheating can demagnitize motor.
Always use PARK control (AD5) to prevent excessive dissipation during standstill.
DO NOT attemp to measure current with out special instructions.

See appendix D for motor wiring schemes.

Unipolar Motors — 6 wire center taps not connected; 8 wire connected as 6 wire.

1 coil = 0.8 x rated 1coil — EXP: 1 amp motor = 0.8 amps

Motor torque = 160% of rated
Acceleration is reduced; increasing current will not improve motor acceleration curve. Series impedance is 4 times single ciol.

BiPolar Motors — 4 wire

or

UniPolar Motors — 6 wire center tap and one leg wired; 8 wire center tap and one leg wired

Motor torque = 100% of rated
Acceleration = Normal

Unipolar Motors — 8 wire in parallel

1 coil = 1.4 x rated 1 coil
Motor Torque = 160% of rated
Acceleration = Improved. Series impedance is 0.5 timessingle coil.

Appendix D Motor Wiring Schemes

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).

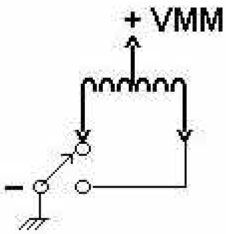
C: PARALLEL COILS. When this configuration is driven at the unipolar current, the motor will perform identical to the specification but the motor will dissipate only one-half the power (it is twice as efficient). When the current is increased by 1.414, to drive the motor at it"s full power rating, the 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.

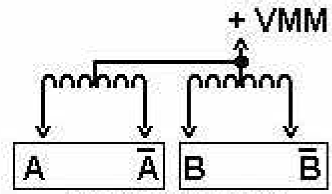
NOTES: If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SID / SMD driver boxes, pins 1 & 3 or $ & 6.

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.

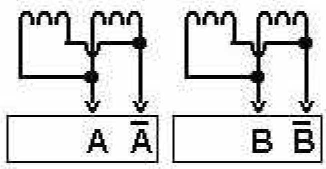


Typical Motor Winding
Unipolar Drive
[only 1/2 motor shown]



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

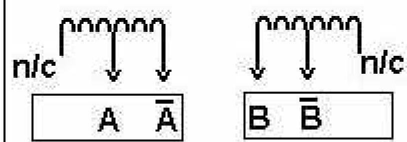
8 Wire - Parallel Coils



Best Speed - Best Torque

Fig. C

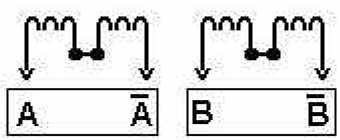
6 Wire - Single Coils



Normal Speed & Torque

Fig. A

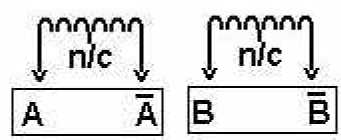
8 Wire - Series Coils



Low Speed - High Torque

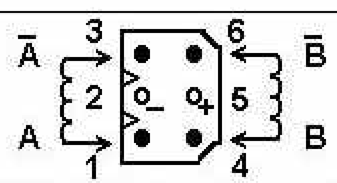
Fig. D

6 Wire - Series Coils

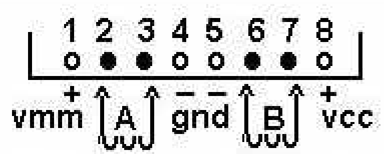


Low Speed - High Torque

Fig. B



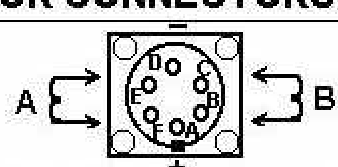
SMD / SID 2/4 Connector



MS/MM Card Connector

MOTION GROUP MOTOR CONNECTORS

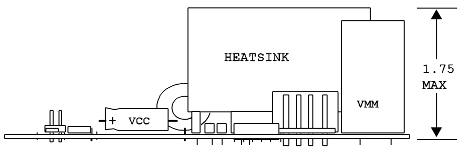
SMD / SID HD Connector

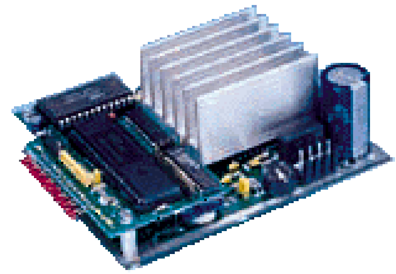


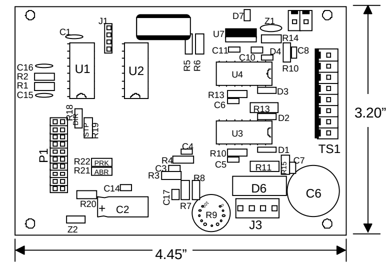
MID / ANT 2.0 Connector

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

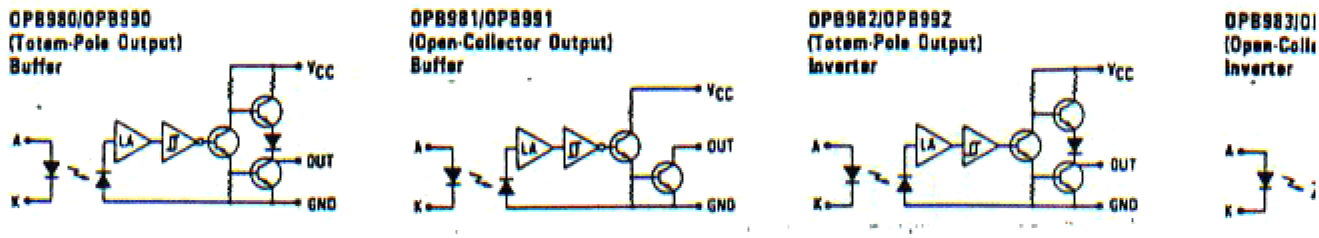
Operating	0 to +70 C
Storage	-40C to +125C
Mounting surface	0 to 70C

TMG the motion group

PO Box 669
Clovis, CA 93613-0669
Ph: 559-325-2727 Fax: 559-325-7117

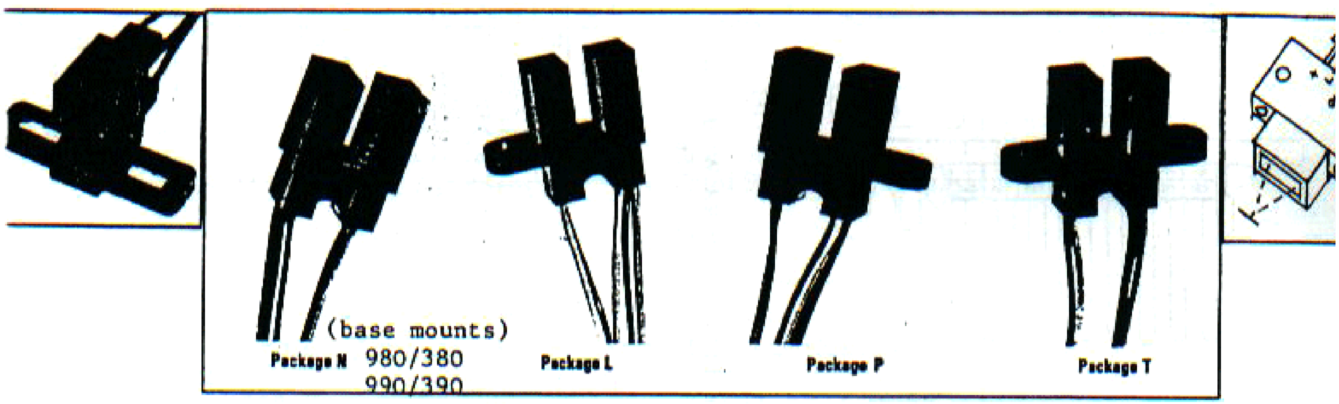
Sales@motiongroup.com
http://www.motiongroup.com

Appendix F



Photologic Slotted Optical

- TRW: OPB 980 and OPB 990 (base mount only)
- OPTEK: KLT 380 and KLY 390 (base mount; KLT 330 and KLT 340 (side mount))
- OMRON: EE-SB5V REFLECTIVE SWITCH (base and side mount combinational)



(side mount)

(side/base)

KLT 330W

EE-SB5V

KLT 340W

REFLECTIV

Features

- Choice of aperture
- Choice of mounting configuration
- Choice of output configuration
- Choice of polysulfone or polycarbonate housing
- Data rates to 250 K baud

Description

The all new OPB980/OPB990 series is intended to provide custom design capabilities in a standard series using 18" minimum length wire leads with PVC insulation. Each device consists of an infrared emitting diode and a Photologic sensor (a monolithic integrated circuit which incorporates a linear amplifier and a Schmitt trigger) mounted on opoposite sides of a 0.125" (3.18 mm) wide slot. Options include Photologic sensor aperture widths and LED aperture widths, four different mounting configurations; buffer-totem pole, buffer-open collector, inverter-totem pole, or inverter-open collector output; and polysulfone (OPB980) housing for dirt and dust protection, or polycarbonate (OPB990) housing for complete opacity to ambient light.

Absolute Maximum Ratins (T_A =25 degrees C unless otherwise noted)

Supply Voltage, VCC (Not to exceed 3 seconds)...+10.0V

Storage Temperature Range..-40 degrees C to +85 degreesC

Operating Temperature Range...-40 degrees C to +70 degreesC

Lead Soldering Temperature Range (1/16 inch(1.6 mm) from case for 5 sec. with soldering iron)............................240 degrees C(1)

Input Diode Power Dissipation...100 mW(2)

Output Photologic Power Dissipation...200 mW(3)

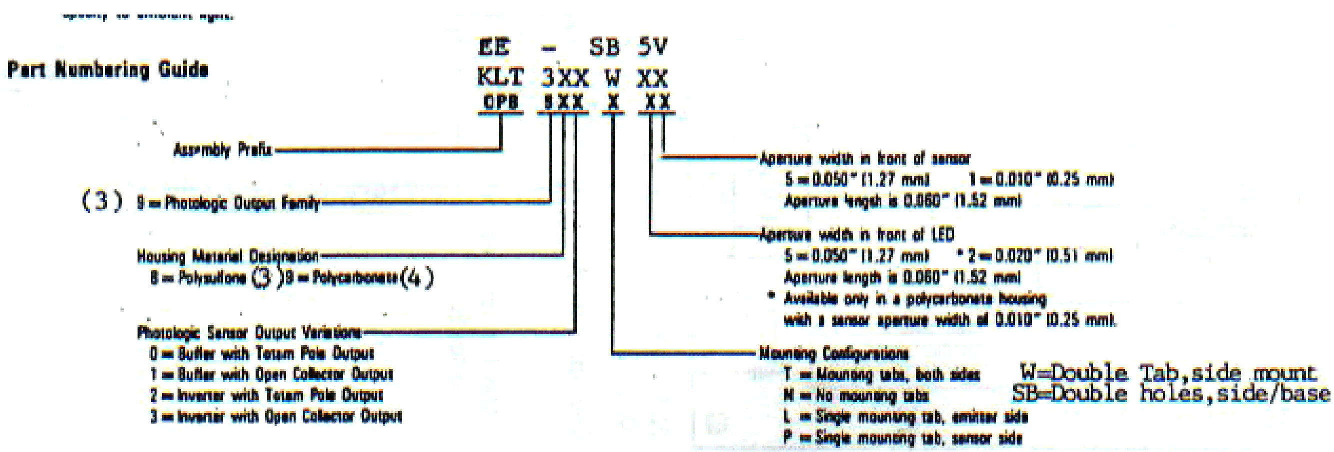
Total Device Power Dissipation...300 mW(4)

Voltage at Output Lead (Open Collector Output) .... 35 V

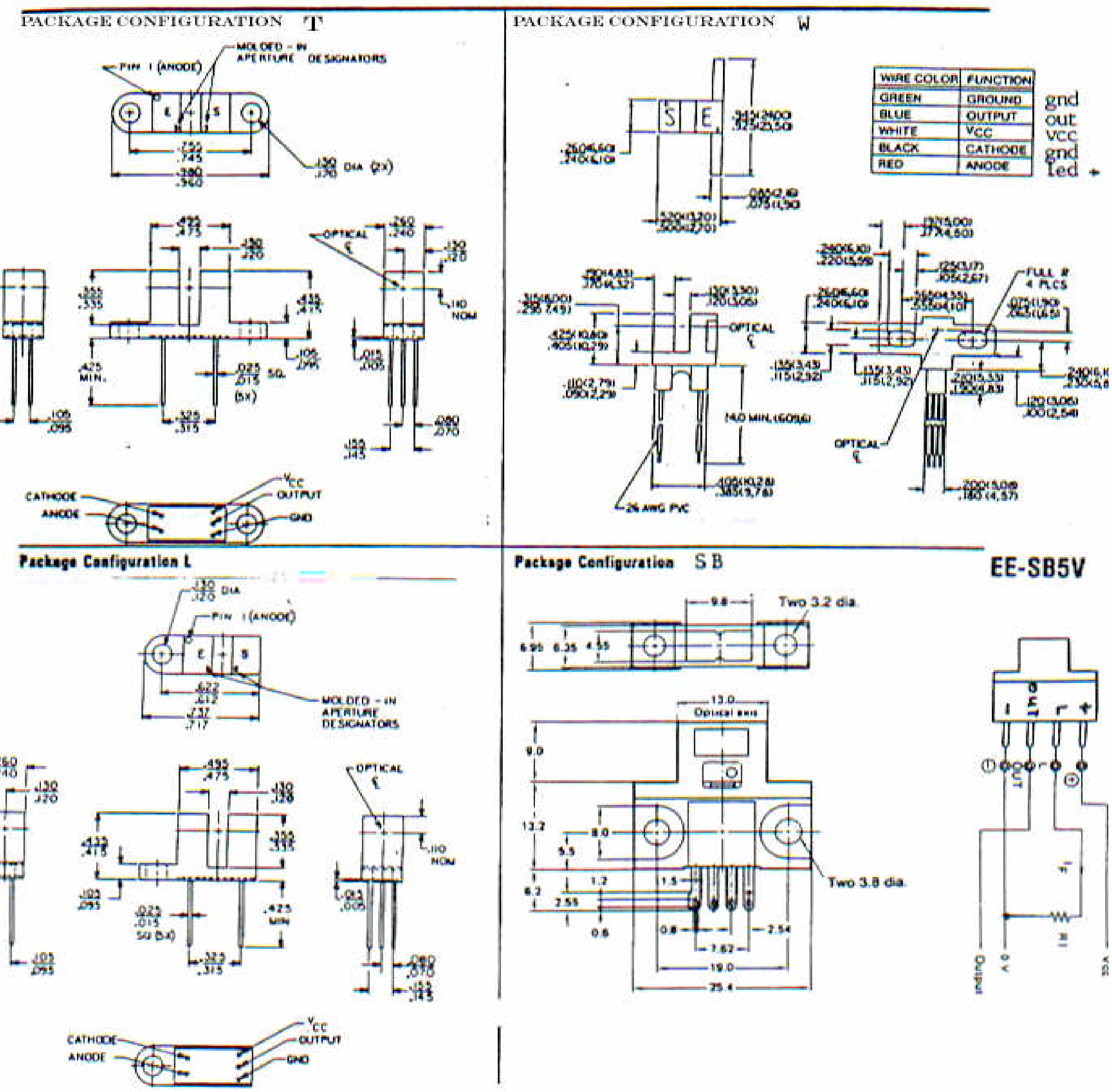
Diode: Forward DC Current .... 40 mA

Diode: Backward DC Voltage...2.0V

Photologic Sensors are a monolithic integrated circuit which incorporates a linear amplifier, schmitt trigger, and output buffer which can be directly connected to computer logic. The superiro stability and clearly defined switching point mandate their use in positioning systems.



COLOR CODE (TRW)	COLOR CODE (OPTEK)	SIGNAL NAME	MOLEX PIN NUMBER	
BROWN	WHITE	VCC +5 vdc	1 (key)	
RED	RED	VLED (LED ANODE)	2	LED SUPPLY VOLTAGE (330 ohm)
BLACK	BLACK	GROUND RETURNS	3	SYSTEM GROUND
ORANGE	GREEN	" "		
GREEN	BLUE	OUTPUT	4	HOME SENSOR OUTPUT



Notes:

1. **Housings are secured in Childrenated Hydrocarbons and Retones methanol and isopropanol are recommended as cleaning agents for both types of housing material.**
2. **Dimensions of aperture opening dependent on housing material shown are polycarbonate.**
3. **Molded number to identify aperture size. See part number guide.**

Appendix I

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-071	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.