SID 2.0

STEP MOTION SYSTEM

OPERATION AND INSTALLATION MANUAL

Intro:

System Components:

Appendix:

SID 2.0 QDHL with Documenation and accessory kit

Motion In Minutes - Plug and Go System

TMG's SIDDEMOB
Developmental Software
SID 2.0 and CY545 Manuals

6' Power cord

RS232 Serial Interface

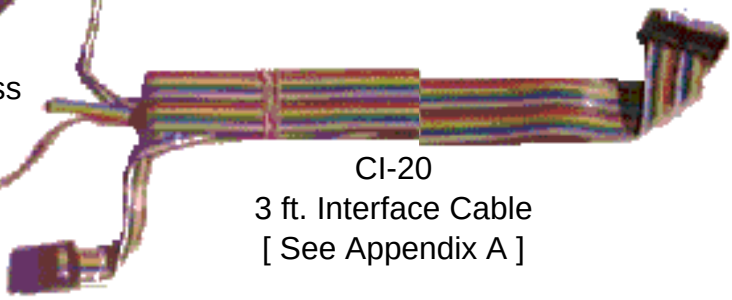
6ft. DE9
Male-Female cable

Current Adjust
[See Appendix C]

Home Sensor
[See Appendix B and F]

Jog Circuit Access

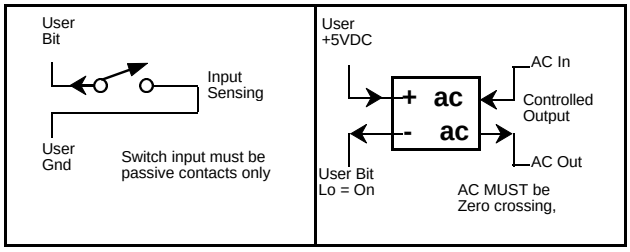
Abort / Limit Loop



CI-20
3 ft. Interface Cable
[See Appendix A]

User I/O Access

Typical I/O Device connections



3 ft. Motor Extension cable
[ME-3]

NEMA Standard
Stepper Motor

Motor Wiring
[See Appendix D]

SID 2.0 System:

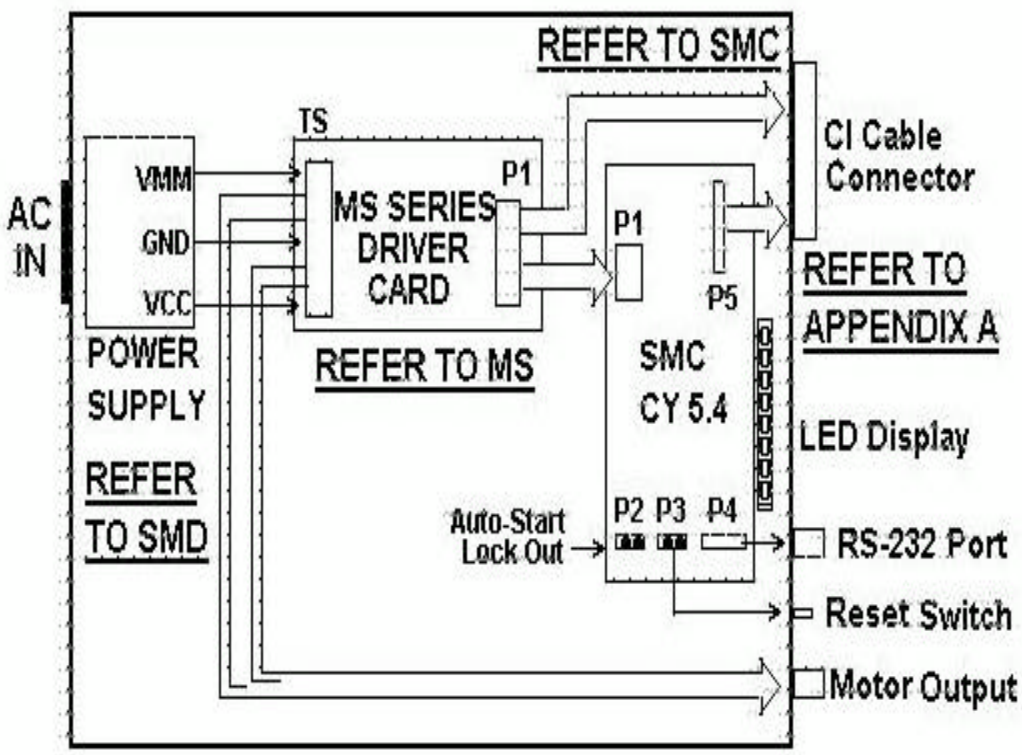
1 ea. SID 2.0 QDHL

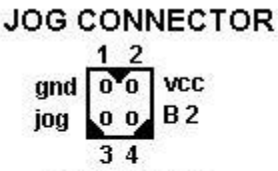
1 ea. Cable and Docs Kit (includes)
- 1. ea. CI-20 cable (3 ft.)
- 1. ea Abort Loop
- 1. ea Optical Home Sensor

1 ea. 6 ft. Serial Comm Cable
1 ea. 3 ft. Motor Extension (ME-3)
1 ea. SID Developmental Software
1 ea. Standard NEMA Stepper Motor

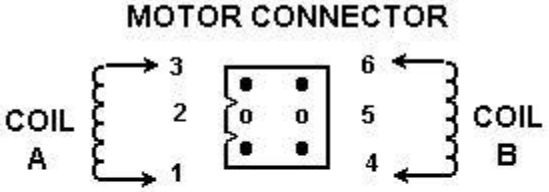
SID Serial Interface System Block Diagram

The SID system consists of power supplies,
a motor driver card and a motion control card.





REFER TO APPENDIX A



Molex Connector pin numbers are embossed on back of nylon housing

REFER TO APPENDIX D

Introduction

The SID motion control system consists of three basic elements; the controller card, the MS driver card and their power supplies (VCC and VMM). The controller card (CY5.4) contains the Cybernetic CY 545 or CY 550 Step Motor Controller and a 2K character EEPROM (non-volatile) for storing application routines. Refer to the Cybernetics 545 manual for a description of the 545 microprocessor and its "High-Level" command set (26 characters and symbols). All actions of this system are controlled by these commands.

Two of the eight User Bits of the 545 (USRB 0-7) are assigned to a specific function. The remainder are for general purpose Input and Output functions (I / O) such as controlling relays or valves (output) and reading switches (input). The command set of the Cybernetic 545 contains instructions such as Test, Wait, Delay, Loop which are used along with the motion instructions to provide a wide range of machine operations. The SID system can be discribed as a "mini-PLC with motion".

The Step pulses and the Direction signal from the CY5.4 controller are connected to the motor driver. Additionally, the Stop signal shifts the driver from Park power to Full power. A Home Sensor channel is also part of the system.

Each system includes a CI cable (controller interface cable). This 20 pin cable is divided into two sections. The I / O section contains + 5 v power and ground as well as six User Bits. The Chassis section connects the Home Sensor, User Bit 2, Jog Switch, and Limit Loop signals back to the controller. Refer to Appendix A for details.

This system is self-contained and can operate independently or under the direct command of a host computer. In Memory Mode, the host computer is used to "teach" the system by sending a string of commands which are stored, for later execution, in the on-board memory of the controller card. In Direct Mode, the host commands are executed immediately by the CY545. A combination of these two modes is also possible; typically macro command strings are loaded to memory and then executed as required by the host.

Addition features are also available as options. These include an Encoder driven, absolute "Position Verification" unit, a Network (SR-4) controller which supports up to 64 channels of independent motion, or a Multiple Motor Adapter (MMA) which provides up to 128 channels of multiplexed motion.

CONTACT FACTORY FOR OPTION INFORMATION ON:

Encoder System ENC 1 (Position Verification)	Expanded I/O option (26 pin I/O)
Heavy Duty Connectors (Mil-Spec)	Multiple Axis Controllers (MMC & MMA)
Network Adaptor (SR4)	RS-422 Serial Communication (twisted pair)

SMC

[Stepper Motor Controller]

OPERATION AND INSTALLATION

ALSO REFER TO:
Cybernetic Micro Systems - CY 545 Step Motor Controller Manual
SIDDEMOB program - Software Listings & Comments

SID (CY 545) COMMAND SET SUMMARY

Command ..... Function ..... Note
A val 24 ..... set position counter to At value ..... Commands are upper case ASCII letters,
B bit # ..... set or clear (/B) User Bit ..... Followed by a space, and a value if required.
C ..... set Continuous stepping mode ..... Values without a suffix are 0 to 255 max.
D val 16 ..... Delay for value in milliseconds ..... Values with 16 suffix are 65535 (64K) max.
E ..... Enter commands to user mem ..... Values with 24 suffix are 16777215 (16 Meg).
F val ..... First (starting) speed of motor ..... Add (byte count) is 64K max. Bit # is 0 to 7.
G ..... Motor Goes the number of steps
H bit # ..... Home motor on bit #
I ..... Initialize 545; software reset
J add ..... Jump to address on mem page
L cnt add ..... Loop to address for count value
N num 24 ..... Number of steps; see Go
O mode ..... Set mOdes of CY controller
P val 24 ..... Moves to an absolute Position
Q ..... Quit Enter commands to mem
R val ..... Set Ramp (top) speed of motor
S val ..... Slope (acceleration) of F to R
T bit # add ..... Jump to add unTil Bit matches
W bit # ..... Wait at add until Bit matches
X ..... eXecute commands at Y add
Y ..... add 16 set mem address counter to Y
Z ..... cnt 16 add Zillion Loops to add for cnt value
0 (number) ..... end of program or stop program
+ (plus) ..... set CW direction for Go move
- (minus) ..... set CCW direction for Go move
/ (forslash) ..... negate prefix for /Bit commands
? command ..... send back command val to host
"message" ..... send back message to host

!!!ATTENTION!!!

Mis-wiring of motor or power supplies WILL damage motor drivers IMMEDIATELY. Motor coils A or B can be reversed; motor will run in the opposite direction. Pairs can be reversed; pair A in coil B for example. CROSS-WIRING, an A and B wire crossed, WILL damage driver. Allowing exposed motor leads to touch each other, ground, or power MAY damage driver. Refer to Appendix D in the MS driver section for wiring schemes.

SMOKE, POPPING, ELECTRONIC ODOR, OR FUSE FAILURE

INDICATES DRIVER FAILURE.

Call the Service Center. Do NOT change fuse or attempt repair without instructions. ADDITIONAL DAMAGE CAN OCCUR !!! Shorted drivers can easily be repaired by replacing the socketed driver arrays.

!!!! WARNING !!!!

NEVER connect or disconnect any of the motor leads or power supply (VMM) leads before disconnecting AC power! Unit may be safely operated WITHOUT motor. However, pause 30 seconds after power off before reconnecting motor (Bleed-Down time).

NOTE !

An understanding of the Cybernetic Motion Controller and its Command Set is required in the following explainations . Refer to the Cybernetic Micro Systems - CY 545 OR 550 Step Motor Controller Manual.

CONTRARY TO POPULAR PRACTICE, IT IS BEST TO READ THIS MANUAL BEFORE ATTEMPTING TO OPERATE SYSTEM. IT WILL SAVE TIME AND PRODUCE BETTER, FASTER RESULTS.

HARDWARE CONFIGURATION

The SMC controller card contains the CY 545 motion controller, EEprom memory, memory latches (2 each), RS-232 receiver / driver, LED status lites and standard crystal (11 MHZ).

Serial Format

The SMC is connected as a RS-232 serial device and communicates with the host computer through the front panel DB-9 S connector (AT style). The serial format is configured in the following manner: ASCII characters, Adaptive Baud, 8 data bits, no parity, and one stop bit. The CTS (Clear To Send) feature of the 545 (User Bit 6) is used as the hardware hand-shake to control communication between the host and the 545. When the 545 is busy, it will set the CTS to hold off transmission.

The SMC is configured that the CTS signal is busy when power is applied to the system. It is sometimes necessary to defeat this function when communicating with the system for the first time. There are two techniques. One is to set the Mode command (O) as part of the Auto-Start routine. The other is to OPEN with the CS = 0, send the mode command, and then re-OPEN with the CS set to the desired value. Refer to the software examples.

During operation from memory or when homing, the CTS function is not fully operational. This is to allow interruption of these routines by the host computer sending a stop command (0 or CR). If other data is sent, incorrect operation will result. To set the SMC 100% busy during operations; 1) disable the CTS function with a Mode command, 2) User Bit 6 will set HI or busy, and 3) as the last instruction, re-enable the CTS.

NOTE: the correct Mode command to defeat the CTS is: O 80H.
the correct Mode command to enable the CTS is: O 0A0H
(Any Hex value starting with a letter must be preceded by a zero)
When the Busy feature is not required, for example during memory operation, then Bit 6 is available as a User I/O input bit.

Memory Format
The memory is configured as 2K bytes of EEPROM (RAM is optional). It is not possible to access memory above address 2047. Note that the memory is in pages of 256 bytes; the CY545 does not allow Jump, Test, or Loop operations across page boundries. The pointer command (Y) is used to move across boundries. A feature of the 545 memory system is the Auto-Start function which recognizes special character flags in the first bytes of memory as a command to run the following program at power-on.

Home Function

This system uses an optical sensor to establish the starting reference or "Home" position at power-on; refer to the Home command (H). Lash-Compensation is included in the home routine. A major advantage of this system is Slip-Detection which provides operation to + zero steps. See Installation and Test for a detailed home procedure.

Limit Loop Function

The CW-CCW Limits function of the 545, pin 4 & 5, is not used in this system. Instead, the driver card will go "free or ABoRt" (CURRENT-OFF) when the Limit Loop is opened (Fail-Safe, Hard-Soft limits). This Limit Loop is enabled by User Bit 0. Refer to Appendix B of the driver card section of this manual.

Note that the CW-CCW inputs are available in this system as the Emergency Stop option. Also, the Inhibit / Abort (pin 8) is not used in this system. This Abort is not the same as the driver abort (ABR). Note that Abort is available, in this system, as the Ramp-To-Stop option.

I/O Function

The Cybernetic User Bits are available at the CI cable connectors and can be used as either inputs or outputs dependent on the command. Note that an output can only drive LEDs such as those in Solid-State relays or optical isolation. An input can only be a passive switch or isolated relay contact across the User Bit and User ground. Connecting any device, at a different potential, to this system through the User Bits, WILL damage the User port; opto-isolation is required. External thumbwheel (pin 12) is not used. Instead refer to the I/O Path option for thumbwheel operation or stand-alone (PLC) mode. The standard CI cable is the 20 pin which provides limits and home sensor signals, access to the User Bit I/O lines, and VCC power & ground. Refer to Appendix A of this manual.

Other Functions

The Jog function (pin 6) is available at the Jog connector of the CI Cable; see Appendix A.

Reserved User Bits.

B 0 Enable Driver; must be Lo to step. B0 LED will be ON.

B 1 Bit 1 is always the Home Sensor.

B 6 Bit 6 Is the Busy Bit (CTS) option. See mOde Command. Bit 6 can also be used, typically in stand-alone applications, as an input.

Displays

OFF = Logic High or true ON = Low or false; pin # refers to CY 545 pinout.

BZ Indicates the inverse of pin 27(User Bit 6) ..... Off = Ready;On = Busy

DR Indicates the polarity of pin 2 (direction) ..... Lo = CW

ST Indicates the polarity of pin 1 (step) ..... Lo = Step pulse

PW Indicates the polarity of pin 3 (stop) ..... Lo = Stepping

SW Indicates the polarity of pin 6 (slew) ..... Lo = Ramp speed

B0 Indicates the polarity of pin 21 (User Bit 0) ..... Lo = Enable all drivers

B1 Indicates the polarity of pin 22 (User Bit 1) ..... Lo = Home Sensor blocked

B2 Indicates the polarity of pin 23 (User Bit 2) ..... General Purpose User Bit

Reset Switch Pushing the reset switch causes a hardware reset (pin 9).

SOFTWARE CONFIGURATION

This system is a serial periferal device directed by ASCI character commands. It is configured exactly as described in the Cybernetics controller manuals; except for those differences as noted in this manual. Special Commands are created to simplify use of the Basic program.

Reserved and Special Software Commands.

CLEAR ..... Writes 0's and CR's to memory.

LOAD [F6] ..... Loads memory. Not same function as Basic F3 key.

EXIT [F5] ..... Required to close comm port, close file, and clear error traps.

comma [,] ..... Do not use comma to separate elements of 545 commands (T,L, and ? M xx).

.....**Comma is a Basic symbol; use space.**

[a,b,c] ..... HP-LED command string is not used.

C ..... Continuous Step Mode is normally not used with the CY545 unless motion can be terminated with an external Abort signal. Refer also to the CY550 which is an advanced version which has a larger selection of on-the-fly software commands.

? E ..... Software command which returns encoder position.

Special Aspects of Some Commands.

W	The Wait command causes the 545 to wait at the instruction therefore incoming stop commands will not be processed. Use a T command in a jump to itself.
L, Z	These loop instructions assume that the first pass of a routine before reaching the loop command was the 1st loop pass. In general, the loop count must be one less than required. Also see J & T below.
T,H,W	These commands are followed by a numeric value in Hexdecimal which is desinated by the H following the value. The decimal and the hex values for 0 to 7 are the same and the H is omitted.
H	Homing is a single step operation. The Busy signal is not continuously set during homing but cycles every step. It is best therefore that homing is executed from memory.
J, T	Any Jump or Test operation, which includes L & Z commands, must not cross the memory page boundry which is ever 256 bytes; 256, 512, 768,1024, etc. Use the Y for global jumps.

INSTALLATION AND SELF-TEST PROCEDURE

1. Connect AC power cord.
2. Connect motors, verify that driver current is correct for motors. See Appendix C for current adjustment and Appendix D for motor wiring.
3. Connect CI cable. Limit Loop must be closed for motor to run.
4. 4. Connect the serial cable and turn-on computer system. Do NOT run the computer program at this time.
5. 5. Connect the AC power and turn-on power switch or supplies. Verify that: AC neon; power is present. DC lamp; motor power (VMM) is OK.

System will run the Auto-Start self-test program as described in the listings; EEPROM sample program. Refer to lines 1000-1800 of the listings in this manual. This test proves that the SID system is operating correctly. Note, this demo will include "homing". The motor will run backwards until the home sensor is blocked (block the sensor with a pencil tip). Then, typically, motor will run back and forth several times. To defeat the self-test, refer to Auto-Start Lockout procedure later in this section. Observe the LED indicator lites while the test is running and note that each action of the system can be monitored and that this self-test is the series of commands listed between the quotes in lines 1000-1800. All actions of the system are the result of COMMANDS, refer to the back cover of the CY 545 manual, either stored in the external memory (Memory Mode) or sent from the host computer (Direct Mode). The third mode (Programming Mode) is when commands are sent from the host and written into the external memory.

COMPUTER TEST PROCEDURE

1. Wait till Auto-Start self-test has completed; B2 LED comes on; PW LED is off.
2. LOAD and RUN the Demo program which will down-load another self-test. Refer to lines 400-800 of the listings. The system will return position when finished: *P= 0000*

NOTE: If the return is in segments:

.....*P=*
.....*00*
.....*00*
.....*00*

exit the program (F5), refer to line 120, and set the correct timebase (T value) for the host computer. Re-start (shift-F5) the program.

NOTE: If the message "system is busy or not connected....." appears, enter Ctrl-Break. The system IS busy (self-test ?) or NOT connected to COMM 1. RESET the SID and allow self-test to finish or correct the serial cabling.

3. Motor Commands.

NOTE: Enter commands (Direct Mode), at the prompt;

Caps Lock on; < = the Enter key; F x = function key.

F9 .....the SID returns position; this indicates communication is OK
/B 0< .....enables motor, B 0 LED is ON or LO
H 1< .....motor 0 will home until the sensor is blocked
P 2000< ....motor will move to position 2000 (2000 steps CW)
F9 .....? P returns P=0002000; position is 2000
P 0< .....motor returns to position 0
B 0<.....free motor

4. Memory Commands

F7 ? Y where is memory byte pointer; Y=xxxx is last byte of self-test
Y 0< sets pointer to byte location 0

? m 22< displays 22 "command lines" of memory (F8 and type 22<)

Note the Auto-Start flags, arrow, 4, V, at byte location 0,1,2 (refer to lines 1030,1040,1050); followed by the first command, O 80H (mode = BUSY, line 1060).

CLEAR< fill the memory with 0's and carriage returns; STOP commands
Y< yes; wait till 0 0 0 0....DONE.
F7 Y=0000
F8 22< memory is cleared
F6 load memory; host goes to line 1000; returns ? P when done
F7 Y=xxxx; last byte of program
Y 0< set memory byte pointer to byte 0
F8 22< ; memory is loaded
CLEAR<
Y< remove the Auto-Start program at this time, if desired

Auto-Start Defeat.
In the event an in-correct program is loaded to the memory, and/or the system locks-up in Auto-Start, it is necessary to manually by-pass the Auto-Start:

A) Locate the Auto-Start Lockout pins; through the 1/4" hole, left side corner, above the motor label.
B) Carefully, short the pins with a #2 phillips driver tip or ballpoint pen.
C) While maintaining the short, Reset the controller. Controller will by-pass. the Auto-Start program.
D) Remove the short. Re-start (shift-F5) the computer demo and CLEAR or over-write the memory program.

It is good practice NOT to arm the Auto-Start flags before a program has been tested using the Y address and X commands. When using the demo program, simply REMark out the flags and change the starting address from Y = 0 to Y = 3; reserves three bytes.

Parameterizing. Refer to the CY 545 MANUAL, SECTIONS 1-12 (Commands), 16 (see StepMotor and Home), 17 (Rate Tables), 19 (good sample program); sections 13,14,15 not used. Typical commands will duplicate the down-load with different values of R, S, and F used in order to determain the best parameters for moving the motor. Refer to the Rate Tables. Repeat Step 3 with different parameters.

Resonance. Resonance (feed-back oscillation between the motor rotor and the motor coils) is a vibration which affects the motor behavior. Typical symptions are shuttering, dropping steps, jumping back and forth, hard running, and excessive noise (unpleasent). All step motors exibit resonance at approximately 100 full step/sec (Low Frequency) and at 1000 full steps/sec (Mid Frequency). This behavior is affected by motor load, power, and speed. The normal procedure is to start at a speed (F command) above the low point and ramp through the mid point (S command) to a higher speed (R command).

To determine the resonance points, set F and S to the lowest value and R above mid freq. Move the motor sufficent steps to reach top speed. Note the points during this acceleration where the motor exhibits abnormal behavior; these are the low frequency nodes. The motor will stall at the mid freq. point. Resonance can be reduced by less power, decoupling the motor and load (isolating couplers; not metal to metal), higher speeds, faster acceleration, and/or smaller step angles.

PROGRAMMING

The software program used with the SID system is only a "Serial Driver" routine. The main purpose of the program is to send and receive commands between the host and the CY 545 microprocessor. The motion control software (firmware) is contained only in the 545. The serial driver contain examples of typical operations required by the host computer software, such as: opening the comm (serial) port, sending/receiving characters, loading the 545 memory, handling the Busy (CTS), and diagnostic capability. Included in the sample program are routines of 545 commands which exercise the motion system during manufacturing tests. Two types of routines are demonstrated; (1) downloading a string of commands from a keyboard file and (2) loading a string of commands to EEprom memory. The memory routine example is an Auto-Start program refered to as a Self-Test. This routine will run when the system is powered-on as proof that the system is operating correctly.

The sample listing is commented and contains information about how to operate a 545 system. It is helpful to "read the listing" even for non-computer types.

Line 0-20 defines the variables and create symbols for control characters.

Line 30-100 assigns the Basic function keys for common functions.

Line 120 creates the time delay used between characters so that fast computers do not get ahead of the serial card and the 545.

Line 130 defines the serial port as the ACTIVE device; PRINT #ACTIVE sends characters to the active port.

Line 200-400 creates the introduction screen display

Line 500-999 is the down-load test routine which is sent to the 545 when this program is first run.

Line 1010-1410 is the Self-Test program shipped in the system EEprom. Note that lines 1030-1050 send the Auto-Start flags in their decimal values. The semi-colons inhibit the carriage return (Enter) until the colon at Line 1060. Refer to the CY 545 manual for the Auto-Start format. The GOSUB 2500 is the time delay for the write cycle of the EEprom memory.

Line 1500-1800 is a sample homing routine with a limited number of re-tries; loop counter, input test, and message transmission are demonstrated in this program.

Line 1800 asks the 545 a question (? P command). The return of the answer from the 545 indicates that the system is responing to the host.

Line 2000-2510 assemblies keyboard entries and sends them to the 545 at the Enter key (CR = carriage return or enter key). Note the special commands at line 2210-2270 which are created commands not part of the 545 command set.

Line 2600-2750 reads any incomming characters from the 545 and prints to the host display screen.

Line 2910-3000 closes the comm ports on Exit (F5) or a computer error code other than ERROR = 24 (comm port is busy).

Line 3000-3150 writes zeros (545 stop command) and carriage returns over the entire memory (Clear command) which erases the memory. The opposite is the Load command which writes the memory.

Line 3300-3400 is the busy error routine.

Line 4000- are the help files.

PROGRAM LISTINGS

```
5 PRINT "SIDDEMOB SERIAL INTERFACE DEVICE DEMO PROGRAM REV D 2-10-95"
10 DEFINT A-Z: REM DEFAULT ALL INTEGERS
20 LF$ = CHR$(10): NL$ = CHR$(0): ES$ = CHR$(27): CR$ = CHR$(13):
    BK$ = CHR$(8): QT$ = CHR$(34) 30 KEY OFF
40 KEY 10, CR$: REM SAVE LAST COMMAND ON SCREEN
50 KEY 9, "? P" + CR$: REM SEND ? P
60 KEY 7, "? Y" + CR$: REM SEND ? Y
70 KEY 8, "? M 22" + CR$: REM SEND ? M and space [add 22 bytes max & cr]
80 KEY 6, "LOAD" + CR$: REM LOAD EEPROM PROGRAM TO MEMORY
90 KEY 5, "EXIT" + CR$: REM EXIT THIS PROGRAM
100 KEY ON

110 CLS : REM XT=50 AT=150 386=300 486=500 TIME BASE VALUE
120 T0 = 300: REM SELECT BASE TIME DELAY FOR COMPUTER SPEED USED
130 ACTIVE = 1: REM DEFAULT COMM PORT ASSIGNMENT
131 ON ERROR GOTO 3300: REM ERROR ROUTINE AT LINE 3300
140 OPEN "COM1:9600,N,8,1,CS000,DS0,CD0" FOR RANDOM AS #1: REM CS SET TO 0 SEC
141 PRINT #1, CR$; CR$; : REM SEND AUTOBAUD CARRIAGE RETURNS TO COM 1
142 PRINT #1, "O 0A0H": REM SET MODE COMMAND-AUTOMATIC BUSY FUNCTION-ARM BIT 6
143 CLOSE #1
144 OPEN "COM1:9600,N,8,1,CS1000,DS0,CD0" FOR RANDOM AS #1: REM CS SET TO 1 SEC
145 PRINT #1, CR$; CR$; : REM SEND AUTOBAUD CARRIAGE RETURNS TO COM 1
150 REM OPEN "COM2:9600,N,8,1,CS000,DS0,CD0" AS #2 REM REMOVE REM'S TO OPEN COM2
      SEE LINE 291
151 REM PRINT #2,CR$;CR$;: REM SEND AUTOBAUD CARRIAGE RETURNS TO COM 2
152 REM PRINT #2,"O 0A0H": REM SET MODE COMMAND-BUSY FUNCTION - ARM BIT 6
153 REM CLOSE #2

154 REM OPEN "COM2:9600,N,8,1,CS1000,DS0,CD0" AS #2: REM CS = 1 SEC
155 REM PRINT #2,CR$;CR$;: REM SEND AUTOBAUD CARRIAGE RETURNS TO COM 2
160 ON ERROR GOTO 3300:
200 LOCATE 5, 1, 1
210 PRINT " THE MOTION GROUP - SERIAL MOTOR DRIVER - MODEL SID w/ CY 545B"
220 PRINT "**********************************************************************"
230 PRINT "**READY TO GO** 9600 BAUD N0 PARITY 8 DATA BITS 1 STOP BIT CS=1 SEC
      SEE LINE 140 AND 150 FOR OPEN COM STATEMENTS"
240 PRINT " SEE ADDITIONAL LINES FOR AUTOBAUD AND BUSY MODE COMMANDS "
250 PRINT " SEE LINE 500 FOR INITIAL DOWN LOAD PROGRAM "
260 PRINT " SEE LINE 1000 FOR EEPROM PROGRAM "
270 PRINT " TYPE CLEAR TO ERASE EEPROM MEMORY "
280 PRINT " USE LOAD [F6] TO LOAD EEPROM MEMORY. F8 TO DISPLAY EEPROM "
290 PRINT " USE Esc OR F5 KEY TO EXIT THIS PROGRAM CORRECTLY "
300 PRINT " BIT 0 ENABLES DRIVER MUST BE LOW TO STEP "
310 PRINT " BIT 1 IS HOME SENSOR - see HOME command "
320 PRINT " BIT 2-5,7 ARE USER BITS "
330 PRINT " BIT 6 IS RS 232 BUSY BIT - used to lock out CPU commands when BUSY "
350 PRINT " "
360 PRINT "Enter commands, at prompt, only after autoboot EEPROM program
                and initial down load program has completed execution and returned position "P=0000000"
370 PRINT "Type HELP for help screen "
380 PRINT " "
390 PRINT " Note| Use RESET switch to STOP SYSTEM; Esc Key = Exit program "
400 PRINT " DOWN-LOAD DEMO IN PROGRESS; WAIT FOR P=0000000 "
410 REM GOTO 1800: REM Remove REM to skip Down-Load sample
```

```
500 REM ******* START OF INITIAL DOWNLOAD COMMANDS PROGRAM ***************
501 REM ******* TYPICAL SERIES OF GENERAL COMMANDS AS A TEST OF MOTION SYSTEM
510 PRINT #ACTIVE, "R 125": REM SEND RATE 125
520 PRINT #ACTIVE, "S 225": REM SEND SLOPE 225
530 PRINT #ACTIVE, "F 15": REM SEND FIRST RATE 15; 30 FOR QUAD STEPers
540 PRINT #ACTIVE, "/B 0": REM SEND SET BIT 0 LOW; ENABLE DRIVER POWER
550 PRINT #ACTIVE, "N 800": REM SEND NUMBER OF STEPS 800
560 PRINT #ACTIVE, "G": REM GO NUMBER OF STEPS
570 PRINT #ACTIVE, "/B 2": REM SET BIT 2 LOW
580 REM PRINT #ACTIVE, "H 1": REM HOME ON B1 - HOMING COMMAND DISABLED
585 PRINT #ACTIVE, "A 1": REM DECLARE CURRENT POSITION AS P = 1
590 PRINT #ACTIVE, "P 0": REM SEND 'MOVE TO POSITION 0'
600 PRINT #ACTIVE, "P 1000": REM SEND 'MOVE TO POSITION XXXXX'
610 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
620 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
630 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
640 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
650 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
660 PRINT #ACTIVE, "/B 3": REM SET BIT 3 LOW
670 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
680 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
690 PRINT #ACTIVE, "/B 4": REM SET BIT 4 LOW
700 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
710 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
720 PRINT #ACTIVE, "/B 5": REM SET BIT 5 LOW
730 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
740 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
750 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
760 PRINT #ACTIVE, "/B 7": REM SET BIT 7 LOW
770 PRINT #ACTIVE, "P 1000": REM MOVE TO POSITION XXXXX
780 PRINT #ACTIVE, "P 0": REM MOVE TO POSITION 0
790 PRINT #ACTIVE, "/B 2": REM SET BIT 2 LOW
800 PRINT #ACTIVE, "+": REM SET DIRECTION +

810 GOTO 1800: REM GO TO ENTER COMMAND PROMPT

1000 REM ******** SAMPLE PROGRAM - EEPROM MEMORY ********
1001 REM Modify the commands between the quotes ********
1002 PRINT "LOADING SAMPLE PROGRAM SEE LINE 1000 WAIT FOR P=0000000"

1010 PRINT #ACTIVE, "Y 0": T = T0: GOSUB 2500: REM SET STARTING MEM ADDRESS
1011 REM T value delay, required if EEPROM is installed - 10 MS write cycle

1020 PRINT #ACTIVE, "E": GOSUB 2500: REM Enter programming mode {save to EEPROM}
1030 PRINT #ACTIVE, CHR$(18); : GOSUB 2500: REM AUTOSTART FLAG 12H - ADD 00
1040 PRINT #ACTIVE, CHR$(52); : GOSUB 2500: REM AUTOSTART FLAG 34H - ADD 01
1050 PRINT #ACTIVE, CHR$(86); : GOSUB 2500: REM AUTOSTART FLAG 56H - ADD 02

1060 PRINT #ACTIVE, "O 80H": GOSUB 2500: REM SET MODE COMMAND;CTS OFF (BUSY)
1061 REM * NOTE * Sets system busy {BIT 6} to lockout CPU commands during
        CY 545 program execution from memory. See Mode {O} Command.
1070 PRINT #ACTIVE, "R 100": GOSUB 2500: REM RATE = 100
1080 PRINT #ACTIVE, "F 150": GOSUB 2500: REM FIRST RATE = 15; FAST HOMING
1090 PRINT #ACTIVE, "S 255": GOSUB 2500: REM SLOPE = 255
1100 PRINT #ACTIVE, "/B 0": GOSUB 2500: REM B0 LO = ENABLE DRIVER OUTPUT
1110 PRINT #ACTIVE, "H 1": GOSUB 2500: REM HOME MOTOR ON B1
1120 PRINT #ACTIVE, "A 1": GOSUB 2500: REM DECLARE HOME POSITION AS P=1
1130 PRINT #ACTIVE, "F 15": GOSUB 2500: REM NEW FIRST RATE FOR RUNNING
1140 PRINT #ACTIVE, "P 6400": GOSUB 2500: REM MOVE TO P=6400; GO +6400 STEPS
1150 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC (11MHZ CLOCK)
1160 PRINT #ACTIVE, "P 3200": GOSUB 2500: REM MOVE TO POSITION XXXX
```

```
1170 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1180 PRINT #ACTIVE, "P 1600": GOSUB 2500: REM MOVE TO POSITION XXXX
1190 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1200 PRINT #ACTIVE, "P 800": GOSUB 2500: REM MOVE TO POSITION XXXX
1210 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1220 PRINT #ACTIVE, "P 400": GOSUB 2500: REM MOVE TO POSITION XXXX
1230 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1240 PRINT #ACTIVE, "P 200": GOSUB 2500: REM MOVE TO POSITION XXXX
1250 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1260 PRINT #ACTIVE, "P 0": GOSUB 2500: REM MOVE TO POSITION XXXX
1270 PRINT #ACTIVE, "R 150": GOSUB 2500: REM SET NEW TOP SPEED; BIG MOVE!
1280 PRINT #ACTIVE, "P 20000": GOSUB 2500: REM MOVE TO POSITION XXXX
1290 PRINT #ACTIVE, "D 900": GOSUB 2500: REM DELAY 1 SEC
1300 PRINT #ACTIVE, "P 0": GOSUB 2500: REM HOME LED (B1) ON
1310 PRINT #ACTIVE, "D 2000": GOSUB 2500: REM DELAY 2 SEC
1320 PRINT #ACTIVE, "P 1": GOSUB 2500: REM HOME LED OFF; BLINKS
1330 PRINT #ACTIVE, "D 2000": GOSUB 2500: REM DELAY 2 SEC
1340 PRINT #ACTIVE, "P 0": GOSUB 2500: REM HOME LED (B1) ON
1350 PRINT #ACTIVE, "D 2000": GOSUB 2500: REM DELAY 1 SEC
1360 PRINT #ACTIVE, "+": GOSUB 2500: REM SET DIRECTION CW; DIR LED ON
1370 PRINT #ACTIVE, "D 1000": GOSUB 2500: REM DELAY 1 SEC
1380 PRINT #ACTIVE, "/B 2": GOSUB 2500: REM SET B2 LO; DONE SIGNAL
1390 PRINT #ACTIVE, "O 0A0H": GOSUB 2500: REM Restore BUSY to active state
1400 PRINT #ACTIVE, "0": GOSUB 2500: REM Stop. Return to Direct mode
1410 PRINT #ACTIVE, "Q": GOSUB 2500: REM Quit programming mode

1500 REM **** SAMPLE HOMING ROUTINE WITH LIMITED NUMBER OF ATTEMPTS******

1510 PRINT #ACTIVE, "Y 600": T = T0: GOSUB 2500: REM TYPICAL STARTING MEM ADD
1520 PRINT #ACTIVE, "E": GOSUB 2500: REM Enter programming mode {save to EEPROM}
1570 PRINT #ACTIVE, "Z 1 600": GOSUB 2500: REM BYTE 600 EMPTY Z COUNTER
1580 PRINT #ACTIVE, "F 150": GOSUB 2500: REM FIRST RATE = 150; FAST HOMING
1590 PRINT #ACTIVE, "N 1": GOSUB 2500: REM NUMBER OF STEPS = 1
1600 PRINT #ACTIVE, "/B 0": GOSUB 2500: REM B0 LO = ENABLE DRIVER OUTPUT
1610 PRINT #ACTIVE, "T 01H 667": GOSUB 2500:
     REM BYTE 623 TEST SENSOR FOR HI; IF LO GO TO BYTE 667
1620 PRINT #ACTIVE, "-": GOSUB 2500: REM SENSOR WAS HI (NOT HOME) GO CCW
1630 PRINT #ACTIVE, "G": GOSUB 2500: REM GO CCW 1 STEP
1640 PRINT #ACTIVE, "D 03": GOSUB 2500: REM DELAY SETS HOMING SPEED
1650 PRINT #ACTIVE, "Z 1000 623": GOSUB 2500:
     REM LOOK FOR HOME 1000 TIMES (LENGTH OF AXIS
1660 PRINT #ACTIVE, QT$ + "CCW FAIL" + QT$ + "B 0": GOSUB 2500: REM FAIL MESSAGE
1663 PRINT #ACTIVE, "Z 1 667": GOSUB 2500: REM BYTE 667 EMPTY Z COUNTER
1665 PRINT #ACTIVE, "T 11H 717": GOSUB 2500:
     REM BYTE 675 TEST SENSOR FOR LO; GOTO BYTE 717=DONE
1670 PRINT #ACTIVE, "+": GOSUB 2500: REM STEP CW UNTIL ONE STEP PAST SENSOR
1680 PRINT #ACTIVE, "G": GOSUB 2500: REM GO 1 STEP
1690 PRINT #ACTIVE, "D 03": GOSUB 2500: REM DELAY SETS HOMING SPEED
1700 PRINT #ACTIVE, "Z 100 675": GOSUB 2500: REM LOOK FOR HOME 100 TIMES
1710 PRINT #ACTIVE, QT$ + "CW FAIL" + QT$ + "B 0": GOSUB 2500: REM FAIL MESSAGE
1720 PRINT #ACTIVE, "A 1": GOSUB 2500:
     REM BYTE 717 SET LASH COMPENSATION VALUE (P=00000001)
1725 PRINT #ACTIVE, "F 15": GOSUB 2500: REM RESTORE FIRST RATE FOR NORMAL STEPPING
1730 PRINT #ACTIVE, "0": GOSUB 2500: REM END PROGRAM(MING)
1740 PRINT #ACTIVE, "Q": GOSUB 2500: REM QUIT PROGRAMMING MODE
1800 A$ = "? P": T = T0: REM Query Position - Indicates completed MEM LOAD
1810 GOTO 2280: REM SEND 'QUERY POSITION' TO DRIVER
```

```
2000 REM******ENTER COMMAND AND READ KEYBOARD*******************************
2010 A$ = "": LOCATE , , 1: REM A$ = NULL STRING; LOCATE CURSOR
2020 PRINT " ENTER COMMAND> "; A$; : REM PRINT 'ENTER COMMAND' & A$
2030 CH$ = INKEY$: REM CH$=A CHARACTER FROM KEYBOARD
2040 IF CH$ = ES$ THEN PRINT CR$; : GOTO 2910: REM HANDLE ESCAPE
2050 IF CH$ <> BK$ THEN GOTO 2140: REM CONTINUE IF NOT BACKSPACE
2060 IF LEN(A$) = 0 THEN GOTO 2030: REM IGNORE EXTRA BACKSPACES
2070 A$ = LEFT$(A$, LEN(A$) - 1): REM OTHERWISE, HANDLE BACKSPACE
2080 Y = CSRLIN: REM CURRENT CURSOR LINE
2090 X = POS(0): REM CURRENT CURSOR COLUMN
2100 LOCATE Y, X - 1: REM MOVE BACK ONE SPACE
2110 PRINT " "; : REM PRINT OUT PREVIOUS NO CR
2120 LOCATE Y, X - 1: REM MOVE BACK ONE SPACE
2130 GOTO 2030: REM GET NEXT CHARACTER
2140 IF CH$ <> "" THEN PRINT CH$; : REM IF NOT NULL PRINT CHARACTER
2150 IF CH$ <> CR$ THEN A$ = A$ + CH$ ELSE GOTO 2200: REM BUILD STRING TIL CR
2155 REM IF CH$ IS CR THEN NEW A$=OLD A$ + NEW CH$; SAVE AT 2200
2160 IF EOF(ACTIVE) GOTO 2030: REM GOTO 2030 IF ACTIVE COM IS NOT EOF
2170 PRINT CR$; : REM MOVE DOWN ONE LINE FOR COM DATA
2180 GOSUB 2600: REM GO GET COM DATA
2190 GOTO 2020: REM RETURN FROM 2600; CONTINUE ENTRY
2200 KEY 10, A$ + CR$: REM SAVE LAST COMMAND; REPEAT KEY
2210 IF A$ = "ESC" THEN GOTO 2910: REM CHECK FOR SPECIAL COMANDS
2215 IF A$ = "EXIT" THEN GOTO 2910:
2220 IF A$ = "CLEAR" THEN GOTO 3000
2230 IF A$ = "LOAD" THEN GOTO 1000
2240 IF A$ = "HELP" THEN GOTO 4000
2250 IF A$ = "1" THEN ACTIVE = 1: GOTO 2010
2260 IF A$ = "2" THEN ACTIVE = 2: GOTO 2010
2270 IF A$ = "?" THEN PRINT " COM"; ACTIVE; "IS NOW ACTIVE . . .": GOTO 2010
2280 IF A$ <> "" THEN PRINT #ACTIVE, A$: REM A$=NOT NULL; PRINT TO COM PORT
2290 GOSUB 2500: REM DO TIME DELAY; SLOW COM CARDS
2300 GOSUB 2600: REM CHECK COM PORT FOR INPUT DATA
2310 IF LEFT$(A$, 1) = "I" THEN A$ = CR$: GOTO 2280: REM PRINT 'I' (RESET)
2320 T = T0: EL = 0: REM CLEAR T AND EL COUNTER SUBROUTINE
2330 GOTO 2010: REM RETURN TO 'ENTER COMMAND' PROMPT
2500 FOR W = 1 TO T: NEXT W: REM LOOP COUNTER SUBROUTINE
2510 RETURN: REM RETURN TO CALLING SUBROUTINE
2600 REM ***** READ DATA FROM ACTIVE COM PORT *********************************
2610 B$ = "": REM SET B$ = NULL
2620 WHILE NOT EOF(ACTIVE): REM IF EOF=1(EMPTY) GOTO 2730 IF EOF=0 GET DATA
2630 J% = LOC(ACTIVE): B$ = B$ + INPUT$(J%, #ACTIVE): REM
2635 REM J% INTERGER (LOC) = # OF CH'S IN COM BUFFER
2637 REM NEW B$ = OLD B$ + STRING (J% # OF CH'S IN ACTIVE COM)
2640 IF MID$(B$, 9, 1) = CHR$(255) THEN B$ = "": E = 1: GOTO 2660: REM MEM IS EMPTY; BLANKS
2650 GOTO 2700: REM CONTINUE FROM 2640; WAS NOT BLANKS
2660 IF E = 1 THEN LOCATE 23, 1:
        PRINT " MEMORY EMPTY ERROR . . . PLEASE PERFORM HARDWARE RESET OF DRIVER
           AND PRESS CARRIAGE RETURN AND CLEAR MEMORY."
2670 PRINT #ACTIVE, CR$; : REM RESTORE AUTO BAUD
2680 PRINT #ACTIVE, CR$; : REM WITH TWO CR'S
2690 GOTO 2720: REM EXIT MEM EMPTY LOOP
2700 E = 0: REM RESET E FLAG
2710 FOR W = 1 TO T: NEXT W: REM WHILE LOOP FOR MORE COM DATA UNTIL W=0
2720 WEND: REM END OF WHILE SUBROUNTINE DO NEXT
```

```
2730 IF LEFT$(B$, 2) = "M=" THEN B$ = " THE FOLLOWING LIST OF COMMANDS CONSUMES " +
       STR$(LEN(B$) - 8) + " BYTES." + CR$ + " BEGINNING AT LOCATION " + B$
2740 PRINT B$; : REM IF INPUT WAS NOT MEM QUERY THEN PRINT IT TO SCREEN
2750 RETURN: REM RETURN TO NEXT LINE FOLLOWING GOSUB
2900 REM *************EXIT PROGRAM ON ERROR SUBROUTINE EXCEPT ERROR 24*******
2910 ON ERROR GOTO 0: CLOSE #1: REM CLOSE #2
2920 STOP
3000 REM *************** WRITE ZEROES TO ALL EEPROM LOCATIONS CLEAR COMMAND **
3010 PRINT : " NOTE . . . . THIS ROUTINE WILL ERASE ALL DATA IN THE EEPROM MEMORY!"
3020 INPUT " CONTINUE (Y or N)"; ANSW$
3030 IF ANSW$ = "N" THEN PRINT " ABORTING CLEAR COMMAND.": GOTO 2320
3040 PRINT " CLEARING EEPROM . . . ";
3050 PRINT #ACTIVE, "Y 0": T = T0: GOSUB 2500
3060 PRINT #ACTIVE, "E": GOSUB 2500
3070 FOR C = 0 TO 1023
3080 PRINT #ACTIVE, "0": PRINT "0";
3090 GOSUB 2500
3100 NEXT C
3110 PRINT #ACTIVE, "Q"
3120 PRINT #ACTIVE, "Y 0"
3130 PRINT
3140 PRINT " . . . DONE."
3150 GOTO 2320
3300 REM ********************** TRAP DEVICE TIMEOUT ERROR **********************
3310 EL = EL + 1: REM SECONDS COUNTER
3320 IF ERR = 24 THEN GOTO 3330 ELSE GOTO 3370: REM COM BUSY TIMEOUT ERROR 24
3330 PRINT " DEVICE IS BUSY OR NOT CONNECTED .... AND HAS BEEN FOR"; EL; "SEC(S)."
3340 PRINT " PERFORM HARDWARE RESET OF CONTROLLER TO TERMINATE . . ."
3350 PRINT " Ctrl-Break TO EXIT AND RESTART THIS PROGRAM IF YOU DO RESET *****"
3360 RESUME
3370 PRINT
3380 PRINT " UNKNOWN DEVICE ERROR . . . PERFORM DEVICE RESET AND RERUN PROGRAM."

3390 PRINT " INCREASE COMPUTER DELAY VALUE AT LINE 120."
3400 GOTO 2910
4000 REM ********************** DISPLAY HELP SCREEN ****************************
4010 PRINT "REMEMBER TO USE shift-F5 TO RE-START THE PROGRAM AFTER THE FIRST "
4011 PRINT "EXIT FROM THIS PROGRAM. THE SECOND TIME F5 IS 'CONTINUE'. "
4012 PRINT " "
4013 PRINT "IF THE MEMORY OR POSITION QUERY ARE RETURNED IN SEGMENTS, "
4014 PRINT "SEE THE T0 VALUE AT LINE 120 "
4015 PRINT " "
4016 PRINT "REFER TO THE CYBERNETICS CY 545 MANUAL FOR THE COMMAND FORMATS "
4017 PRINT " "
4018 PRINT "TO DEFEAT THE DOWN-LOAD TEST PROGRAM WHICH IS RUN AT THE START "
4019 PRINT "OF THIS PROGRAM, REMOVE THE REM AT LINE 410 "
4020 PRINT " "
4021 PRINT "TO DEFEAT THE SELF-TEST PROGRAM WHICH RUNS AT POWER-ON OR RESET OF "
4022 PRINT "THIS SID SYSTEM, CLEAR THE MEMORY. "
4023 PRINT " "
4024 PRINT "IF THE SID DOES NOT RESPOND CORRECTLY AFTER AN ATTEMPTED MEMORY "
4025 PRINT "LOAD, MOST OFTEN A FAULTY PROGRAM HAS BEEN LOADED AND THE SYSTEM "
4026 PRINT "IS TRAPPED IN A ENDLESS AUTO-START. SEE AUTO-START LOCKOUT PROCEDURE."
4027 PRINT " "
4028 PRINT " "
4029 PRINT "FOR MORE HELP: CALL THE SERVICE CENTER 800-424-STEP {415-969-5829} "
4030 GOTO 2010: REM RETURN TO ENTER COMMAND ROUTINE
```

SERIAL CABLES

XT TYPE. CPU DB-25 (IBM STYLE) CONTROLLER DB-9S (AT)

PIN 1 ..... Frame Ground <----------> Shell (solder)

PIN 2 ..... TX Transmit ----------> PIN 3 RX Receive

PIN 3 ..... RX Receive <---------- PIN 2 TX Transmit DB-25 to DB-9 Adaptor

PIN 5 ..... CTS Clear <---------- PIN 8 DSR Ready

PIN 7 ..... Signal Ground <----------> PIN 5 Signal & Frame

AT TYPE CPU DB-9P (IBM STYLE) CONTROLLER DB-9S (AT)

Note : DB-9 Controller is wired as a Null Modem (pin to pin)

PIN 3 ..... TX Transmit ----------> PIN 3 RX Receive

PIN 2 ..... RX Receive <---------- PIN 2 TX Transmit

PIN 8 ..... CTS Clear <---------- PIN 8 DSR Ready Pin to Pin cable

PIN 5 ..... Signal Ground <----------> PIN 5 Signal & Frame

PIN 4 ..... DTR Ready ----------> PIN 4 DTR Ready

Shell ..... Frame Ground <----------> Shell Signal & Frame

MAC DIN. CPU DIN-8 (EIA-422) CONTROLLER DB-9S (AT)

PIN 5 ..... RX In- <---------- PIN 2 TX Transmit

PIN 3 ..... TX Out- ----------> PIN 3 RX Receive

PIN 2 ..... CTS Hand In <---------- PIN 8 DSR Ready

PIN 4 ..... Signal Ground <----------> PIN 5 Signal & Frame MAC to IBM Adaptor Cable

PIN 8 ..... RX In+ <----------> PIN 5 Signal & Frame

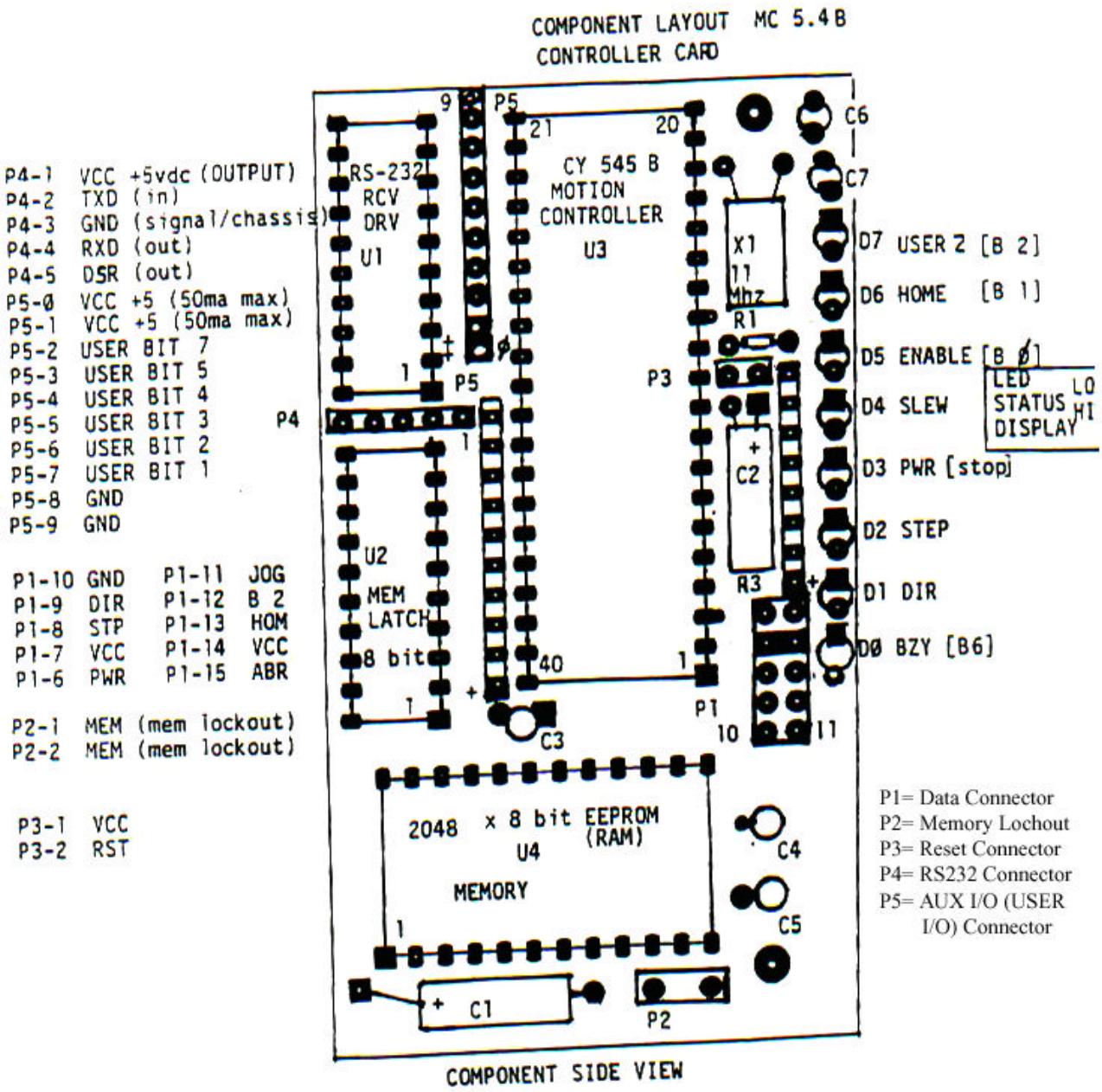
PIN 1 ..... DTR ----------> PIN 4 DTR

Shell ..... Frame Ground <----------> Shell Signal & Frame

The Controller signal DSR (Data Set Ready) is wired to the host CPU signal CTS (Cleared To Send). When the controller is busy, the DRS will set HI or or busy and pull CTS HI or not Clear To Send; CPU will not send.

If the CS parameter in the OPEN COM statement of the host software is zero, the CTS signal will be ignored and commands sent to the controller will be lost or jam the controller. Typical indications of the host failing to see the CTS (increase delay value) are: motion or homing stops when host program is run, motor runs backwards at high speed forever, or only part of memory routine is completed.

SMC DIAGRAM


COMPONENT LAYOUT MC 5.4B
CONTROLLER CARD
P4-1 VCC +5vdc (OUTPUT)
P4-2 TXD (in)
P4-3 GND (signal/chassis)
P4-4 RXD (out)
P4-5 DSR (out)
P5-0 VCC +5 (50ma max)
P5-1 VCC +5 (50ma max)
P5-2 USER BIT 7
P5-3 USER BIT 5
P5-4 USER BIT 4
P5-5 USER BIT 3
P5-6 USER BIT 2
P5-7 USER BIT 1
P5-8 GND
P5-9 GND
P4
P1-10 GND
P1-9 DIR
P1-8 STP
P1-7 VCC
P1-6 PWR
P1-11 JOG
P1-12 B 2
P1-13 HOM
P1-14 VCC
P1-15 ABR
P2-1 MEM (mem lockout)
P2-2 MEM (mem lockout)
P3-1 VCC
P3-2 RST
RS-232 RCV DRV
U1
CY 545 B MOTION CONTROLLER
U3
X1 11 Mhz
R1
P3
P5
C6
C7
D7 USER 2 [B 2]
D6 HOME [B 1]
D5 ENABLE [B Ø]
D4 SLEW
LED STATUS DISPLAY LO HI
D3 PWR [stop]
D2 STEP
D1 DIR
DØ BZY [B6]
C2
R3
U2
MEM LATCH
8 bit
C3
P1
2048 x 8 bit EEPROM (RAM)
U4
MEMORY
C4
C5
C1
P2
P1= Data Connector
P2= Memory Lochout
P3= Reset Connector
P4= RS232 Connector
P5= AUX I/O (USER I/O) Connector
COMPONENT SIDE VIEW

MC 5.4 Schematic

Please call factory for details

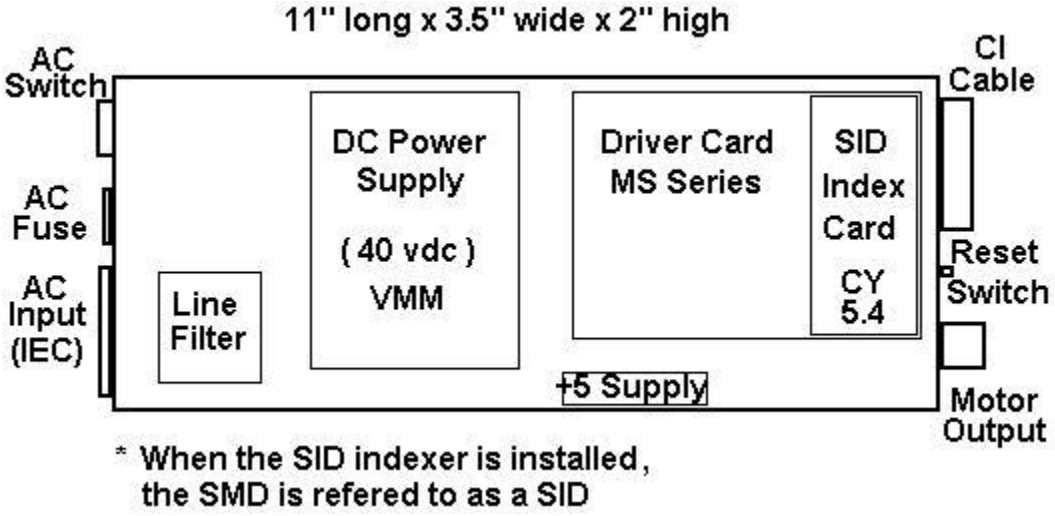
1-800-424-7837

11 MHZ RATE TABLE (STANDARD CRYSTAL)

R 0	18	R 43	1605	R 86	3485	R 128	5238	R 171	6944	R 214	10300
R 1	22	R 44	1649	R 87	3526	R 129	5268	R 172	6997	R 215	10417
R 2	46	R 45	1694	R 88	3567	R 130	5299	R 173	7052	R 216	10536
R 3	69	R 46	1743	R 89	3609	R 131	5329	R 174	7106	R 217	10659
R 4	92	R 47	1787	R 90	3652	R 132	5361	R 175	7161	R 218	10784
R 5	115	R 48	1833	R 91	3696	R 133	5392	R 176	7218	R 219	10913
R 6	137	R 49	1878	R 92	3741	R 134	5424	R 177	7275	R 220	11044
R 7	160	R 50	1926	R 93	3788	R 135	5456	R 178	7333	R 221	11179
R 8	183	R 51	1971	R 94	3835	R 136	5489	R 179	7392	R 222	11317
R 9	206	R 52	2015	R 95	3884	R 137	5522	R 180	7453	R 223	11458
R 10	229	R 53	2065	R 96	3934	R 138	5556	R 181	7514	R 224	11603
R 11	252	R 54	2107	R 97	3986	R 139	5589	R 182	7576	R 225	11752
R 12	275	R 55	2152	R 98	4038	R 140	5624	R 183	7639	R 226	11905
R 13	298	R 56	2198	R 99	4092	R 141	5658	R 184	7703	R 227	12061
R 14	321	R 57	2247	R 100	4148	R 142	5694	R 185	7768	R 228	12222
R 15	344	R 58	2292	R 101	4186	R 143	5729	R 186	7835	R 229	12387
R 16	367	R 59	2338	R 102	4224	R 144	5765	R 187	7902	R 230	12557
R 17	412	R 60	2381	R 103	4264	R 145	5802	R 188	7971	R 231	12731
R 18	459	R 61	2431	R 104	4304	R 146	5839	R 189	8041	R 232	12911
R 19	504	R 62	2477	R 105	4344	R 147	5876	R 190	8112	R 233	13095
R 20	550	R 63	2518	R 106	4386	R 148	5914	R 191	8185	R 234	13285
R 21	596	R 64	2568	R 107	4428	R 149	5952	R 192	8258	R 235	13480
R 22	641	R 65	2612	R 108	4472	R 150	5991	R 193	8333	R 236	13682
R 23	688	R 66	2657	R 109	4516	R 151	6031	R 194	8410	R 237	13889
R 24	733	R 67	2704	R 110	4561	R 152	6071	R 195	8488	R 238	14103
R 25	780	R 68	2753	R 111	4606	R 153	6111	R 196	8567	R 239	14323
R 26	825	R 69	2795	R 112	4653	R 154	6152	R 197	8648	R 240	14550
R 27	871	R 70	2838	R 113	4701	R 155	6194	R 198	8730	R 241	14785
R 28	917	R 71	2892	R 114	4750	R 156	6236	R 199	8814	R 242	15027
R 29	963	R 72	2938	R 115	4799	R 157	6279	R 200	8900	R 243	15278
R 30	1008	R 73	2976	R 116	4850	R 158	6322	R 201	8987	R 244	15537
R 31	1054	R 74	3025	R 117	4902	R 159	6366	R 202	9076	R 245	15805
R 32	1100	R 75	3066	R 118	4955	R 160	6410	R 203	9167	R 246	16082
R 33	1146	R 76	3118	R 119	4982	R 161	6455	R 204	9259	R 247	16369
R 34	1192	R 77	3161	R 120	5009	R 162	6501	R 205	9354	R 248	16667
R 35	1237	R 78	3194	R 121	5037	R 163	6548	R 206	9450	R 249	16975
R 36	1284	R 79	3228	R 122	5064	R 164	6595	R 207	9549	R 250	17296
R 37	1329	R 80	3262	R 123	5093	R 165	6643	R 208	9649	R 251	17628
R 38	1374	R 81	3297	R 124	5121	R 166	6691	R 209	9752	R 252	17974
R 39	1421	R 82	3333	R 125	5150	R 167	6740	R 210	9857	R 253	18333
R 40	1467	R 83	3370	R 126	5179	R 168	6790	R 211	9964	R 254	18707
R 41	1513	R 84	3408	R 127	5208	R 169	6841	R 212	10073	R 255	19097
R 42	1559	R 85	3446			R 170	6892	R 213	10185		

SECTION 2: SMD - Stepper motor drive assembly

OPERATION AND INSTALLATION



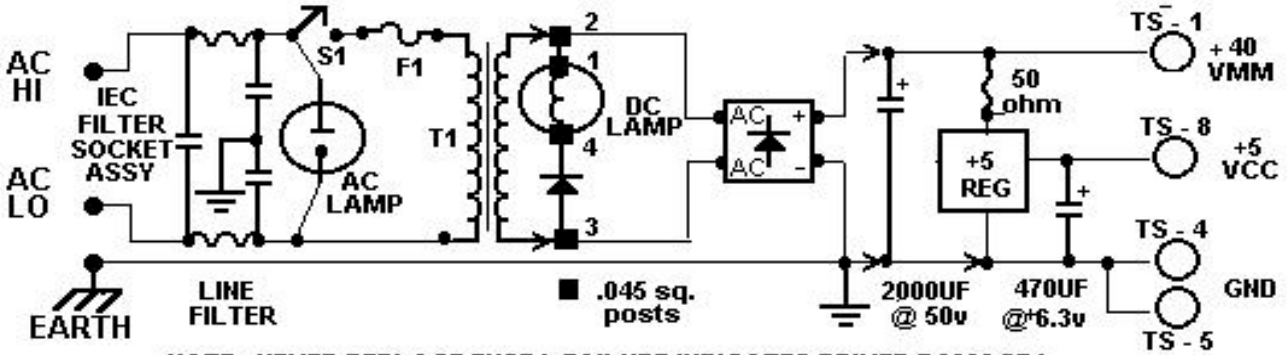
The SMD assembly consists of the CY 5.4 controller, the MS 2.0 step motor driver, all DC power supplies, and an AC power entry. The DC power supplies provide +5 vdc TTL computer (VCC) and +40 vdc motor (VMM). The VCC supply is over-current protected. In addition, A 1 amp AC fuse protects the entire assembly.

NOTE: NEVER REPLACE THE FUSE.

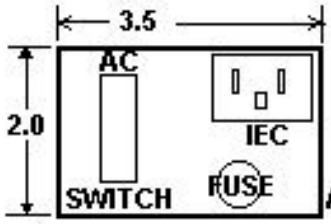
FUSE FAILURE INDICATES DRIVER FAILURE.

The green chassis lamp indicates VMM power on. The neon lamp in the power switch indicates that AC power is present to the SMD. The SMD has a motor connector (see Appendix D), power connector, serial connector (refer to serial cable section), and LED status indicators. The reset switch, when closed, will RESET the system. The lock-out pins (P4), when shorted with the clip, will prevent the Auto-Start. The 20 pin CI cable connector provides access to the spare I/O lines, limit loop, home sensor and VCC power/ground. Refer to Appendix A of this manual.

SID POWER SUPPLY WIRING DIAGRAM

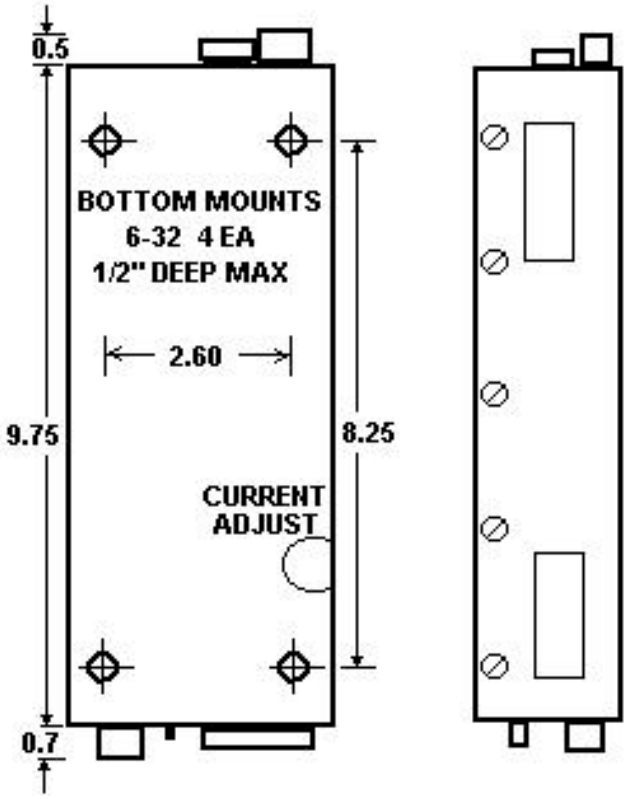


NOTE : NEVER REPLACE FUSE ! FAILURE INDICATES DRIVER DAMAGE !

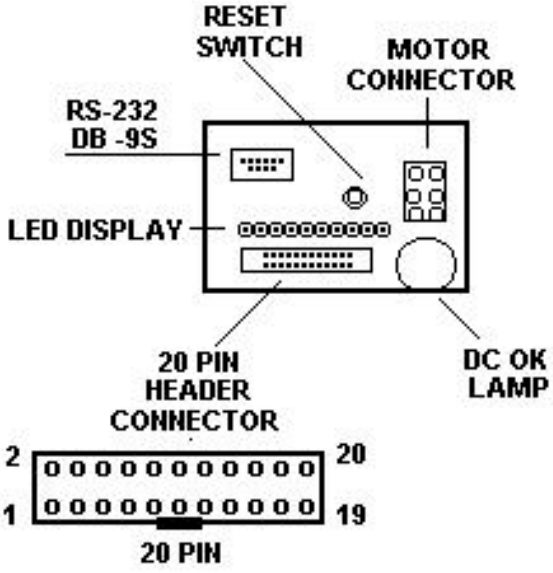


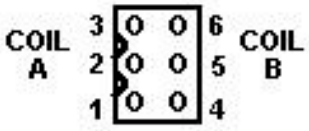
MOUNTING DATA

Weight = 3 lb



CONNECTORS

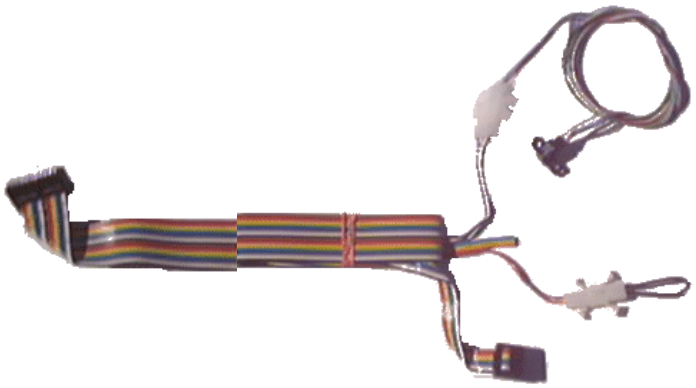




PIN 2 & 5 ARE SPARE

MOLEX 6-PIN # 03 06 1061

APPENDIX A: CI CABLE DIAGRAM FOR SID SYSTEMS



Optical Home Sensor

1. Sensor +5 VCC [Blk]
2. Sensor LED + [Wht]
3. Sensor LED GND - [Gry]
4. Sensor Out [Pur]

[Chassis] Mechanical Interface

2. VLED -- Wht
4. Home -- Pur
6. VCC -- Grn
8. B 2 -- Orn
10. Limit Loop -- Brn

1. Sensor +5VCC -- Blk
3. Sensor Gnd. -- Gry
5. User Gnd. -- Blu
7. Jog -- Yel
9. Limit Loop -- Red

J1

2 1

20 19

5. User GND [Blu]
6. User +5 VCC [Grn]
7. Jog Switch In [Yel]
8. User Bit 2 [Orn]

9. Limit Loop In [Red]
10. Limit Loop Out [Brn]

Limit Loop

CI-20 Cable
J1 Connector
pos. numbers

12. VCC -- Wht
14. B 7 -- Pur
16 B 4 -- Grn
18. B 2 -- Orn
20. Gnd -- Brn

11. VCC -- Blk
13. B 5 -- Gry
15. B 3 -- Blu
17. B 1 -- Yel
19. Gnd. -- Red

12(9) 11(10)

J2

20(1) 19(2)

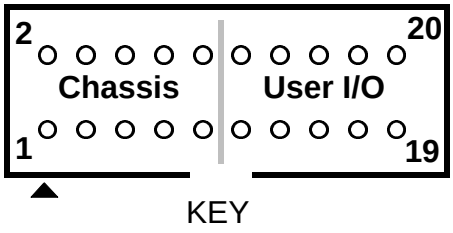
12(9)

[User] I/O Interface

CI-20 Cable
J2 I/O Connector
pos. numbers

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

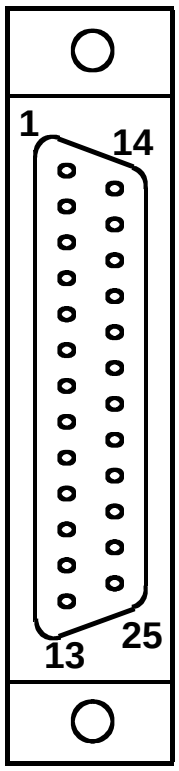
P1 (CI20 Header)
SID Box Header Pin out

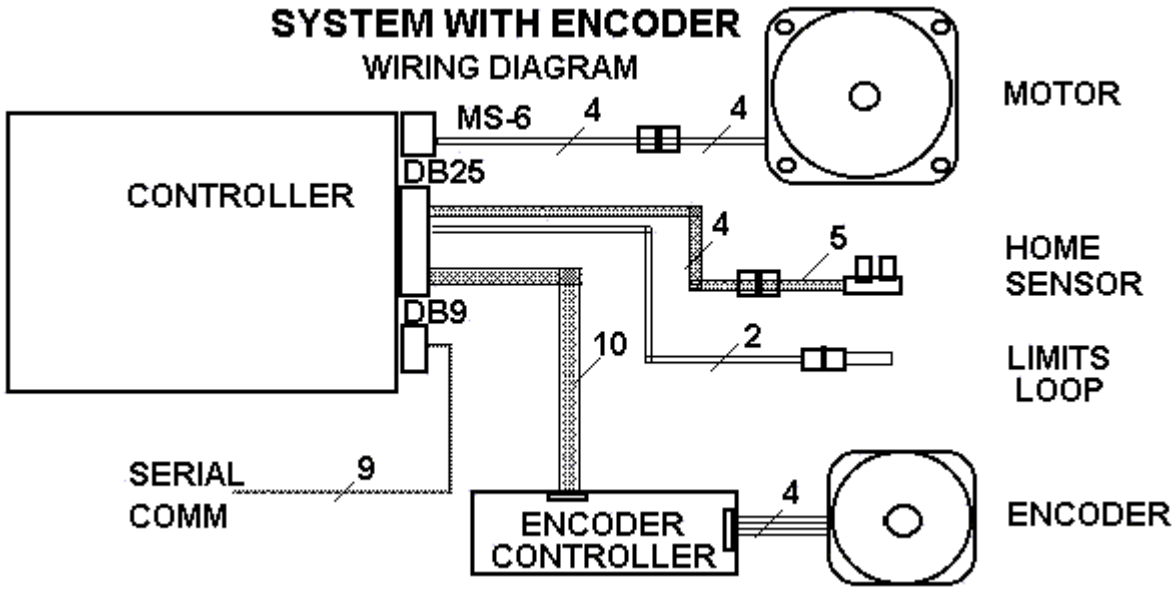


APPENDIX A: CI CABLE DIAGRAM FOR MID SYSTEMS

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	





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.

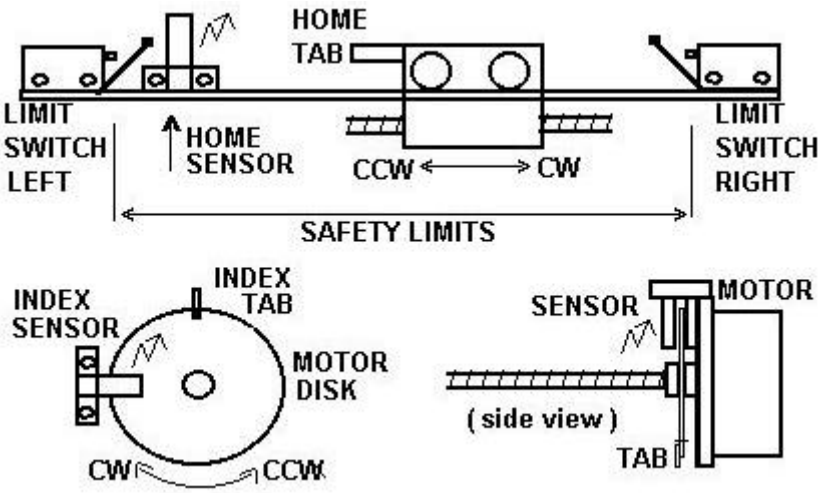
CENTER HOME AND CONTIGUOUS SLIP DETECTION. If the home sensor is located at the center of axis motion and a step bar is mounted along the entire motion path, then the home position can be verified each time the system crosses the center line. A stepped bar is thin strip with a left high side and a right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

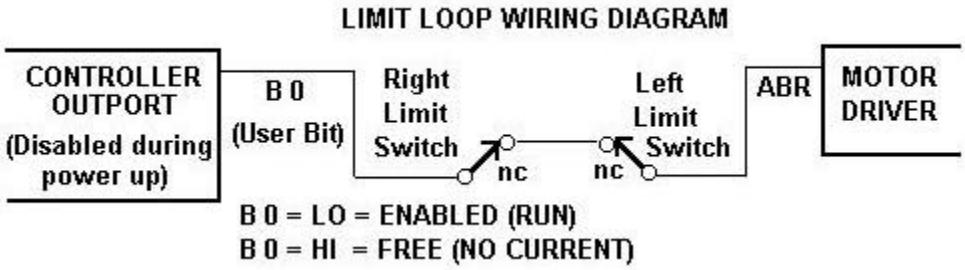
Lash compensation adds or subtracts steps, at each change of direction or because of other forces, to take-up the lash error. Lash compensation is accomplished during the slip-detection process. When the system is slip-detected the first time, the sensor will not close at position 0 because of the lash; 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.



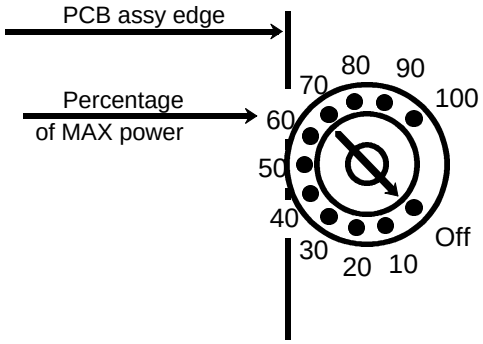
NOTE: CONTRARY TO POPULAR PRACTICE, IT IS UNWISE AND UNSAFE TO SENSE LIMITS AND OTHER SAFETY CONDITIONS THROUGH THE COMPUTER INPUTS PORTS.

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).

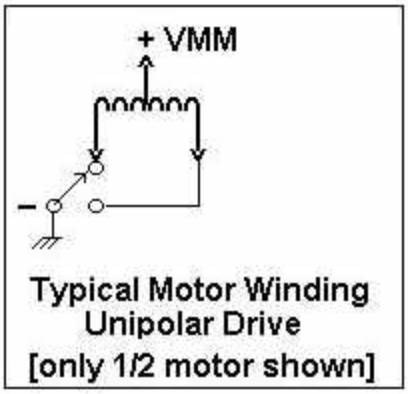
C: PARALLEL COILS. When this configuration is driven at the unipolar current, the motor will perform identical to the specification but the motor will dissipate only one-half the power (it is twice as efficient). When the current is increased by 1.414, to drive the motor at it"s full power rating, the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

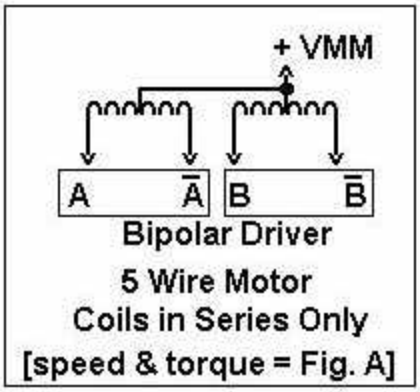
NOTES: If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SID / SMD driver boxes, pins 1 & 3 or $ & 6.

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.

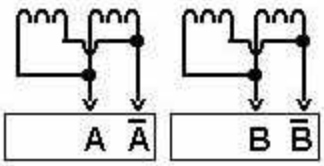


Typical Motor Winding
Unipolar Drive
[only 1/2 motor shown]



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

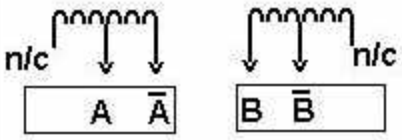
8 Wire - Parallel Coils



Best Speed - Best Torque

Fig. C

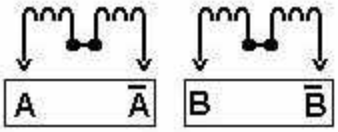
6 Wire - Single Coils



Normal Speed & Torque

Fig. A

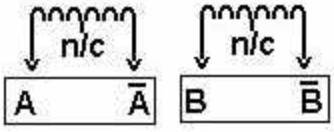
8 Wire - Series Coils



Low Speed - High Torque

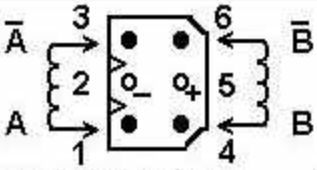
Fig. D

6 Wire - Series Coils

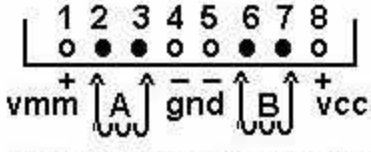


Low Speed - High Torque

Fig. B



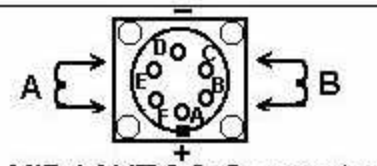
SMD / SID 2/4 Connector



MS/MM Card Connector

MOTION GROUP MOTOR CONNECTORS

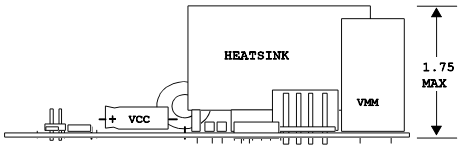
SMD / SID HD Connector



MID / ANT 2.0 Connector

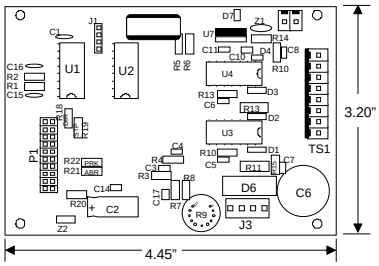
MS 2.0 High Performance Stepper Motor Driver.

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 -

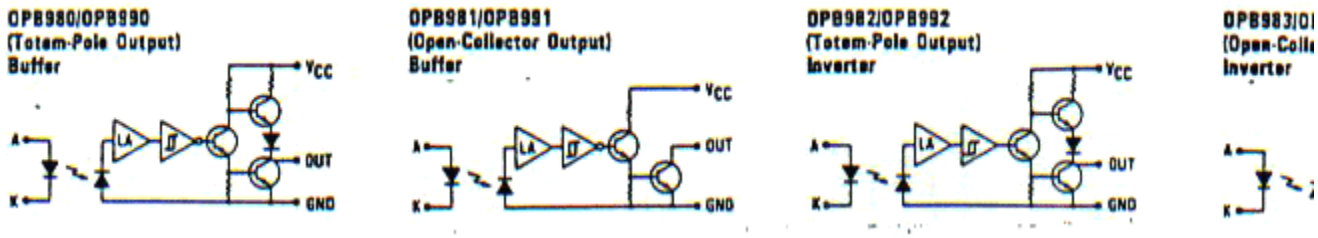
Input Voltage - Logic	+5 VDC (TTL)
Input Voltage - Motor	+12 to 40 VDC
Output Current (Adjustable)	0.05 to 2.0 Amps / Phase
Step Frequency	500 KHz Max
Step size	QUAD or Full/Half
Protection	Over-Temp, Over-Voltage, Over-Current
Current Reduction at standstill	Automatic: 0.5 sec after last step input.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

Temperature

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

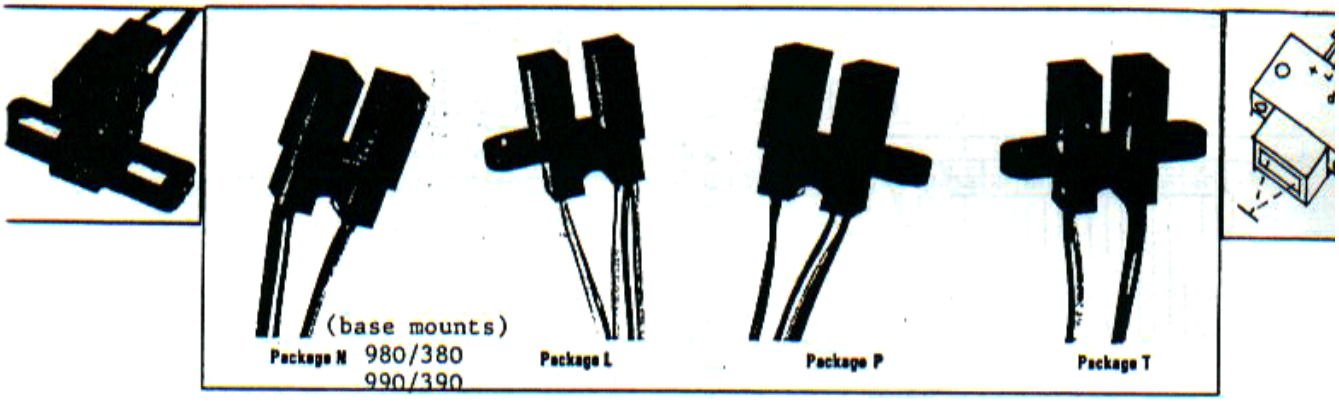
TMG the motion group
PO Box 669
Clovis, CA 93613-0669
Ph: 559-325-2727 Fax: 559-325-7117
Sales@motiongroup.com
http://www.motiongroup.com

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, V_{CC} (Not to exceed 3 seconds).....+10.0V

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

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

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)

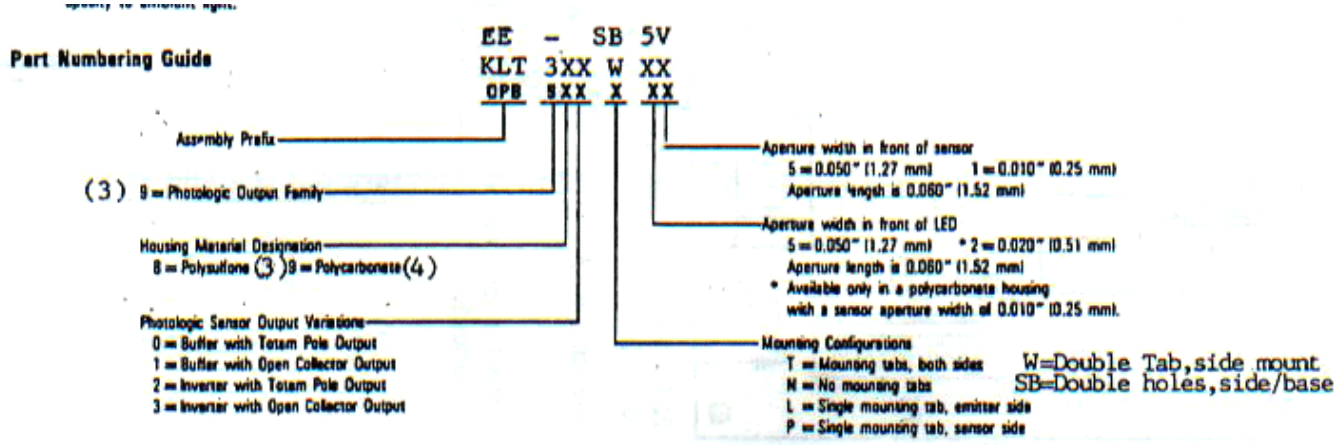
Total Device Power Dissipation.....300 mW(4)

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

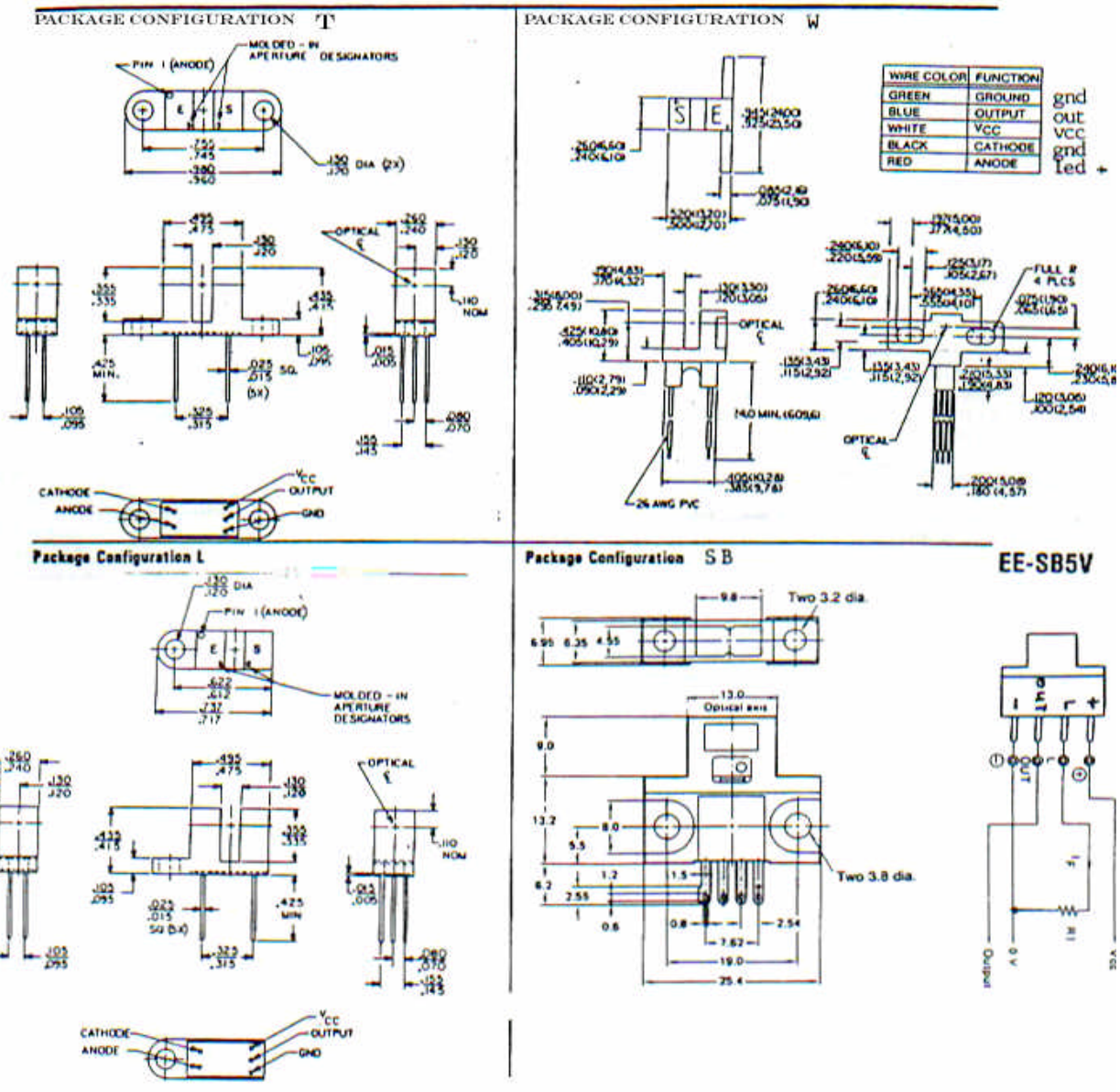
Diode: Forward DC Current ..... 40 mA

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.

SPECIFICATIONS - SID and MID 2.0

PARAMETER	MIN	MAX
Power Motor Supply Voltage	12	40
Current (No Motor)	150	160
PWM frequency MD10A	18	24
Motor Current MS2.0	0.05	2.0
Step Pulse Input Voltage	0	+5.0
Sink Current	12	20
Pulse High	1	
Pulse Low	1	
Rise Time		0.5
Fall Time		0.5
Frequency		500
Logic '1' volts	+1.8	+2.0
Sink Current	12	20
Logic '1' volts	+1.8	+2.0

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

Environmental		
Operating Temperature	-20	+50
Humidity (non-condensing)	0	95
Shock	100	
Altitude	30.000	
Mechanical		
Weight	3	
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	

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.

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

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