MMC - 4S

MULTIPLE MOTOR CONTROLLER

OPERATION AND INSTALLATION MANUAL

WITH MULTIPLE MOTOR ADAPTOR AND CY 545 B

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THE MOTION GROUP LOS ALTOS, CALIFORNIA

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SECTION 1: SMC - Step Motion Controller

SECTION 2: SMD - Step Motion Drive Assembly

SECTION 3: MM2 - Mini-Step Translator Driver

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INTRODUCTION

The MMC-4S motion control system consists of three basic elements: the controller unit, the multiplexers, and the drivers (MM 2.0). The controller contains a CY 545 (550) step motor controller microprocessor. The multiplexer section allows the CY545 to control up to four step motor channels by multiplexing the motion signals between the channels. 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.

In this system, the User Bits of the 545 (USRB 0-7) are assigned to control both the 8 line output mux and the 8 line input mux. The output lines (0,1,2,3) select a motor channel; the remainder (4,5,6,7) are available for general purpose output functions. Refer to the I/O Assignments in the Demo software. The 8 line input mux inputs the home sensors on lines 0,1,2,3; the remainder (4,5,6,7) are general purpose.

When a channel is selected, the Step pulses and the Direction signal from the CY 545 are directed to a motor driver by the multiplexer. Additionally, selection shifts the driver from Park power to Full power. The muxers also direct the signal from the Home Sensor, for that motor, back to the controller.

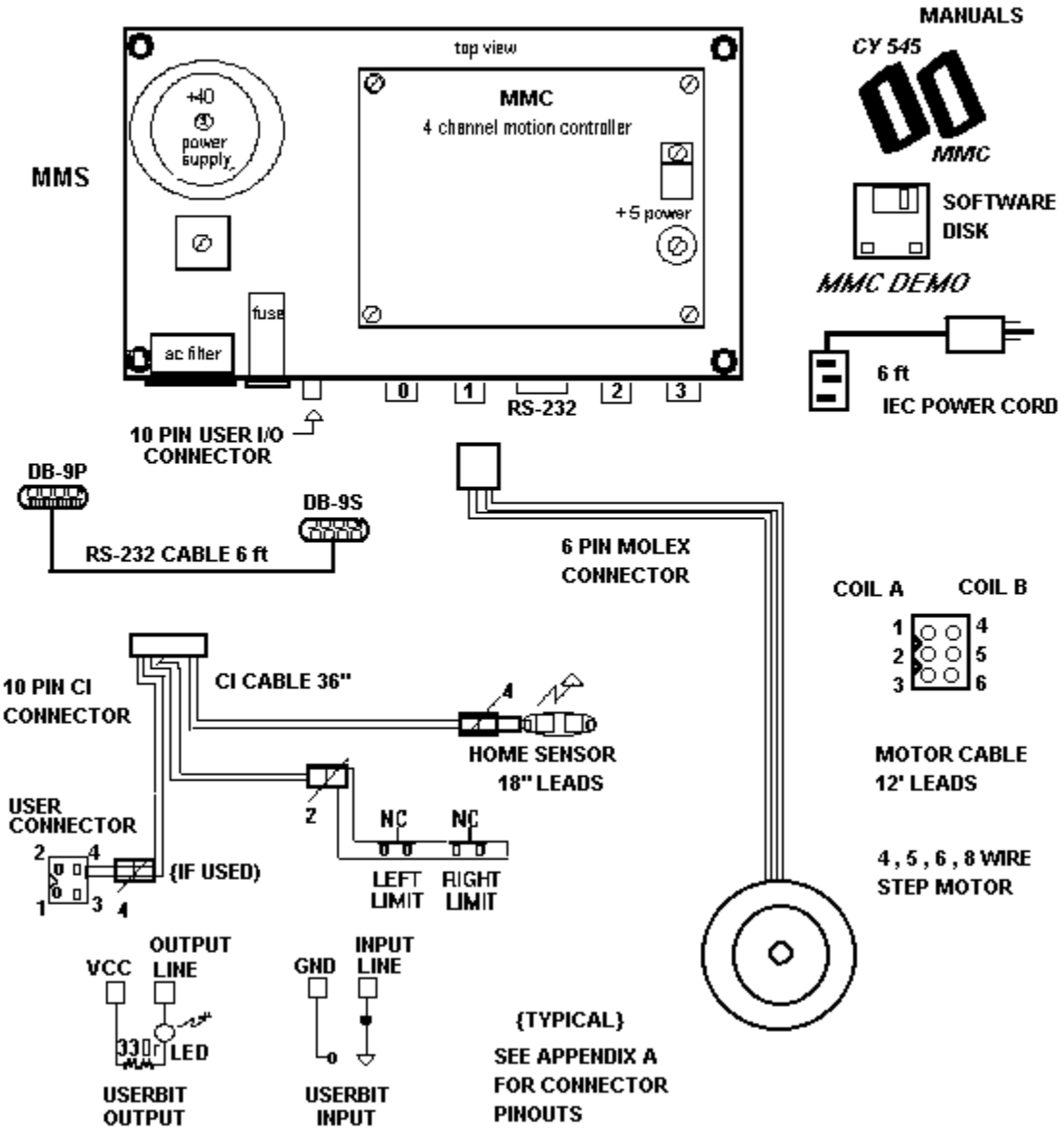
Normally, one channel is selected at a time as the MMC card only generates signals for one step motor. If more than one channel is selected, the motors will make identical moves; the Bi-Direction option enables individual direction of each axis. Note, however, that only one motor can be homed at a time. Curves and 3-D motions are produced by single stepping the system and switching motors each step. A major advantage of this system is the ability to trace true point-to-point patterns at up to 1K steps/sec.

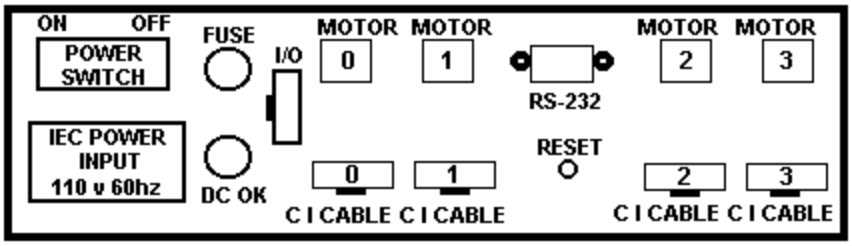
Each system includes CI cables (chassis interface cable). This 10 pin cable connects the Home Sensor and Limit Loop signals back to the controller. The 8 User I / O lines, as well as power and ground, are available at their connector. Refer to Appendix A for details.

This system is self-contained and can operate stand-alone or under the serial command of a host computer. In stand-alone mode, a 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.

MULTIPLE MOTION SYSTEM - COMPONENTS

MOTION IN MINUTES - PLUG AND GO SYSTEM features Cybernetics CY 545





card

NEVER REPLACE FUSE
ADDITION DAMAGE WILL OCCUR

Bare cards fuse at P 1 connector
Boxed cards have front panel fuse

For CI cable pin out See Appendix A & F
For Current Adjust See Appendix C
For Motor Connect See Appendix D & E

!!!! 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 Motion Controller Manual.

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

SMC

OPERATION AND INSTALLATION

ALSO REFER TO: Cybernetic Micro Systems - CY 545 Step Motor Controller
MMC4DEMO program - Software Listings & Comments

SECTION 1

CONTENTS **PAGE**

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**

HARDWARE CONFIGURATION

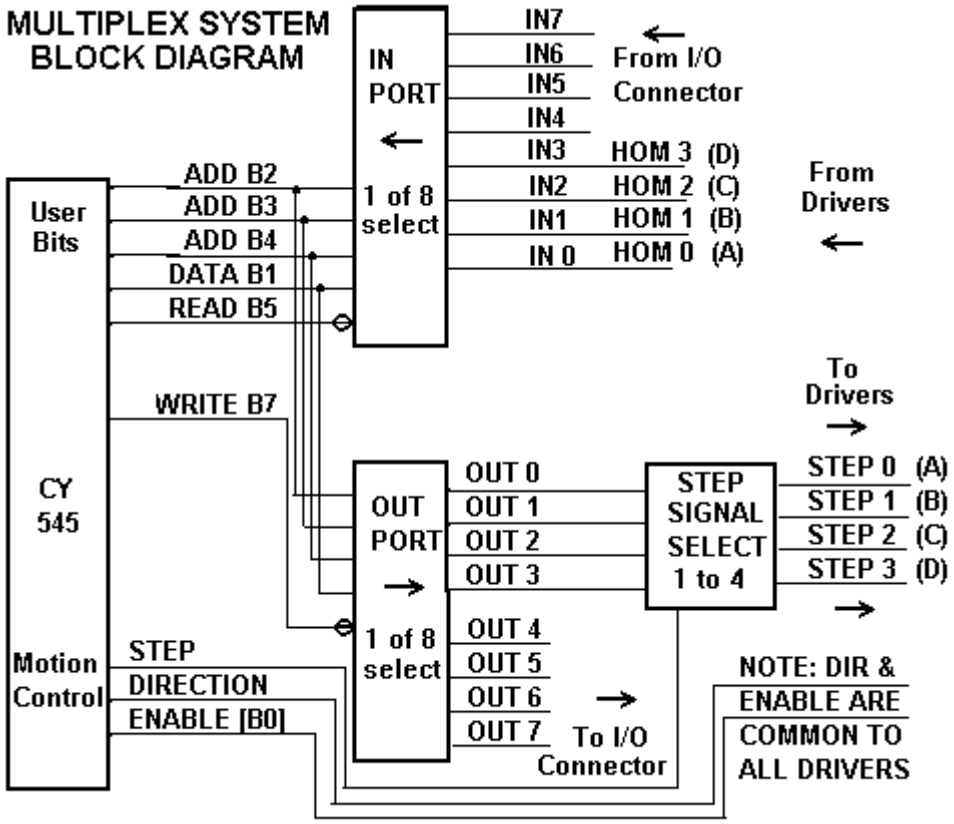
The SMC (step motion controller) section contains the CY 545B motion chip, EEPROM memory, memory latches, RS-232 receiver / driver, LED status lites and standard crystal (11 MHZ). The multiplexer and select LEDs are located above the 545 section.

Serial Format. The SMC is connected as an 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.

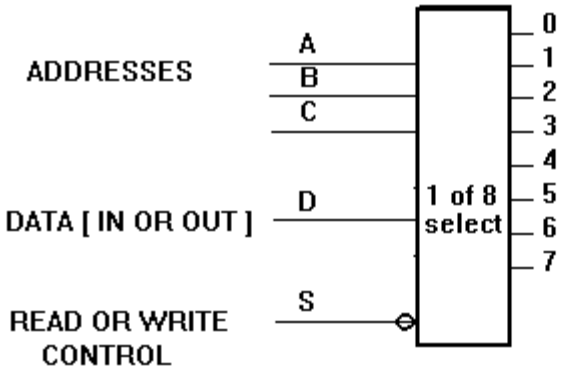
The SMC is configured that the CTS signal is busy when power is applied to the system. It is sometimes necessary to defeat this function when communicating with the system for the first time. There are two techniques. One is to set the Mode command (O) as part of the Auto-Start routine. The other is 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 listings; line 140-145.

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, Bit 6 is available as a User I/O control bit.

Memory Format. The memory is configured as 2K bytes of EEPROM or RAM (8K/16K/64K is optional). It is not possible to access memory above the maximum address. 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.



MULTIPLEX SYSTEM



TRUTH TABLE

C	B	A	SELECT
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

WRITE = LO = OUTPUT FOLLOWS DATA
WRITE = HI = OUTPUT STORES DATA

READ = LO = DATA FOLLOWS INPUT
READ = HI = DATA - NO CHANGE

1 = HI = LED OFF

0 = LO = LED ON
{NEGATIVE LOGIC}

Multiplexer Format: Inputs. The multiplexers are controlled by the CY 545 User Bits 1 through 5 and 7 (Bit 6 is the busy bit). Bit 5 selects the input port when LO (LED = on). Bits 2, 3, 4, the mux addresses, select which of the 8 lines will input to Bit 1 of the 545. B1 must be set HI (LED=OFF) during input operations. The input commands of the 545 are used only with Bit 1. Input lines 0, 1, 2, 3 are the the home sensors; the rest are general purpose and available at the I/O connector. Inputs 0, 1, 2, 3 (HOM) and 4, 5, 6, 7 (IN) have status LED's.

Multiplexer Format: Outputs. When Bit 7 is LO (LED=ON), the output port is selected. Again Bits 2, 3, 4 address one of eight output lines. Outputs 0, 1, 2, 3 select drivers 0, 1, 2, 3 (motors A,B,C,D). Lines 4, 5, 6, 7 are for general purpose. {NOTE: If the Bi-Direction Option is installed, lines 4,5,6,7 are the direction controls for drivers 0,1,2,3.} The selected output line follows the state of Bit 1 when B7 is LO (LED=ON); transparent latch. The state of B1 is latched when B7 is set HI (LED=OFF). Outputs 0, 1, 2, 3 (SEL) and 4, 5, 6, 7 (OUT) have status LED's.

CAUTIONS: If the address (B2, B3, B4) is changed while B7 is LO, the old address will retain the state of B1 as will the new. Since the addresses can only be changed one at a time, care should be taken to prevent other addresses from being changed indirectly. Normally, Bit 7 should be HI during addressing.

Bits B7 (write) and Bit 5 (read) must never be LO at the same time. B1 is never locked LO when B5 is LO (reading B1). Note that the I/O lines are unprotected TTL +5 vdc and must be connected only through optical isolation such as solid state relays. The inputs can be only switched to system ground; any other scheme requires optical coupling.

The 545 User Bits are set HI at power-on or reset. However, the mux outputs may be in any state and therefore, must be cleared all HI, usually by the Auto-Start program. Refer to the examples in the demo programs. Note that although the motor driver may be selected at power-on, the drivers are disabled (aborted or free) until B0 (driver enable) is set LO.

Disabled Functions. The Limit function of the 545's pin 4 & 5 is not used. The drivers will go "free" when the Limit Loop is opened (Fail-Safe, Hard-Soft limits); the Limit Loop is enabled by User Bit 0. Refer to Appendix B of the driver card section of this manual. The Jog function (pin 6) and the Inhibit/Abort (pin 8) are also not used; this Abort is not the same as the driver abort (ABR). External thumbwheel (pin 12) is not available.

Multiplex Code Table **LED ON = LO = ZERO** **LED OFF = HI = ONE**

Selected Function	B2	B3	B4	B5	B7	Binary
OUT 0 (MOTOR 0)		ON	ON	ON	OFF	ON 00010
OUT 1 (MOTOR 1)	OFF	ON	ON	OFF	ON	10010
OUT 2 (MOTOR 2)	ON	OFF	ON	OFF	ON	01010
OUT 3 (MOTOR 3)	OFF	OFF	ON	OFF	ON	11010
OUT 4 (OUT 4)		ON	ON	OFF	OFF	ON 00110
OUT 5 (OUT 5)			OFF	ON	OFF	OFF ON 10110
OUT 6 (OUT 6)	ON	OFF	OFF	OFF	ON	01110
OUT 7 (OUT 7)		OFF	OFF	OFF	OFF	ON 11110

B1 = LO to select motor or set OUT low; B1 = HI to deselect or set high.

NOTE: To select a motor.
1] Set an address (B 2, B 3, B 4).
2] Select the desired motor with the output function (B 7=LO, B 1=LO).
3] Close the output latch (B 7=HI) and set B1 HI, if required, for homing.
It is possible to select more than one motor channel, however the motors will both move the same number of steps.

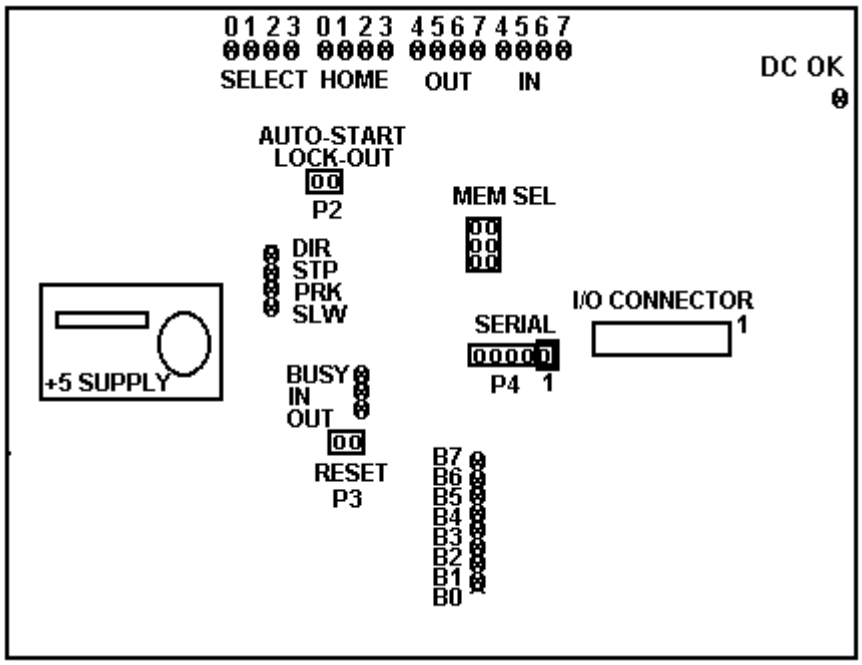
IN 0 (HOME 0)	ON	ON	ON	ON	OFF	00001
IN 1 (HOME 1)	OFF	ON	ON	ON	OFF	10001
IN 2 (HOME 2)	ON	OFF	ON	ON	OFF	01001
IN 3 (HOME 3)	OFF	OFF	ON	ON	OFF	11001
IN 4 (IN 4)	ON	ON	OFF	ON	OFF	00101
IN 5 (IN 5)	OFF	ON	OFF	ON	OFF	10101
IN 6 (IN 6)	ON	OFF	OFF	ON	OFF	01101
IN 7 (IN 7)	ON	ON	ON	ON	OFF	11101

B1 = HI when in read mode; B5 LED is ON or LO.

NOTE: To home a selected motor:
{Verify that address is for selected motor and B1 is HI.}
1] Set B 5 to read the inputs (B 5=LO).
2] Command H 1 (home the motor on Bit 1).

Special Bit Command Format.
Refer to page 6-1,2 of the CY 545 manual. It is possible to change the first five Bits with a single command thereby simplifing controlling the address value. The demo program examples are one bit at a time for a clearer demonstration.

MCC CARD DISPLAYS AND CONTROLS



LED DISPLAYS & CONTROLS (pin numbers refer to CY 545 pins).

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

Motion Display. (OFF = Logic One or true ON = Logic Zero or false)

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

Serial Port Display.

BZ	Indicates the inverse of pin 27 (User Bit 6) Off = Ready; On = Busy
IN	Indicates Incoming serial data to CY 545 from host computer
OUT	Indicates Outbound serial data from CY 545 to host computer

Select Display.

0	Indicates motor selection channel 0; motor shifted to full power
1	Indicates motor selection channel 1; "
2	Indicates motor selection channel 2; "
3	Indicates motor selection channel 3; "

Home Display.

0	Indicates home sensor of channel 0 at all times; on = Lo
1	Indicates home sensor of channel 1 "
2	Indicates home sensor of channel 2 "
3	Indicates home sensor of channel 3 "

Output Display

4	Indicates output bit 4 at all times; on = Lo
5	Indicates output bit 5 "
6	Indicates output bit 6 "
7	Indicates output bit 7 "

Input Display

4	Indicates input bit 4 at all times; on = Lo
5	Indicates input bit 5 "
6	Indicates input bit 6 "
7	Indicates input bit 7 "

User Bit Address Displays

B7	Indicates Bit 7 (write)
B6	Indicates Bit 6 (busy bit - inverse of BZ indicator)
B5	Indicates Bit 5 (read)
B4	Indicates Bit 4 (multiplex address 2, the MSB)
B3	Indicates Bit 3 (multiplex address 1)
B2	Indicates Bit 2 (multiplex address 0, the LSB)
B1	Indicates Bit 1 (input / output data signal)
B0	Indicates Bit 0 (Lo = Enable all drivers)

INSTALLATION AND SELF-TEST PROCEDURE

NOTE: PROCEDURE IS FOR COMPLETE ASSEMBLIES ONLY.
REFER TO POWER WIRING DIAGRAM FOR MCC CARDS.

1. Connect AC power cord. (to observe LEDs, remove cover first).
2. Connect motors, verify that driver current is correct for motors.

See Appendix C for current adjustment and Appendix D for motor wiring.
NOTE: It may be smarter to connect only ONE motor when wiring for the first time. Typically, current pots are factory set to the 50 % position.

3. Connect CI cables. Limit Loops must be closed for motors to run.
4. Connect the serial cable and turn-on computer system.
NOTE: Do NOT run the computer program at this time.

5. Connect the AC power and turn-on power switch or supplies.
Verify that: AC neon; power is present. DC lamp; motor power (VM) is on.
On board: Green LED = VM on. Red LED = +5 supply is on.

System will run the Auto-Start self-test program as described in the listings; EEPROM sample program. Refer to lines 1000-1700 of the listings in this manual. This test proves that the MMC system is operating correctly. Typically each 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 1000-1700.

All actions of this system are the result of these 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; B0 is out, motors are free.

2. LOAD and RUN the Demo program which will down-load another self-test. Note, however, this demo will include homing. Refer to lines 400-800. The motors will, in turn, run backwards until the home sensors are blocked (block the sensors with a pencil tip). The system will return position when finished: *P = 000000.*

NOTE: If the return of position 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 MMC and allow self-test to finish or correct the serial cabling.

3. Direct Command Exercise: Enter commands at the prompt.
NOTE: UPPER CASE ONLY ; < = the Enter key; Fx = use function key.

F9 the MMC returns position; this indicates communication is OK
/B 0< enables all motors; B 0 LED is ON or LO
/B 2< sets B 2 LO; multiplex address to channel 0 (motor 0)
/B 3< sets B 3 LO; "
/B 4< sets B 4 LO; "
/B 7< opens OUTPUT latch
/B 1< brings the OUT 0 channel LO; selects motor 0; step(100%) power
B 7< closes the latch
B 1< set B 1 HI when homing
/B 5< opens INPUT latch; read B 1 on channel 0
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=000200*; position is 2000
P 0< motor returns to position 0
B 5< close INPUT latch
/B 7< open OUTPUT latch; channel 0 deselects; B1 was HI
B 7< close latch
B 0< free all motors
Refer to lines 400-800 of the listings for other motors.

4. Memory Command Exercise:

F7 ? Y where is memory byte pointer; *Y=xxxx* is last byte of self-test
Y 0< sets pointer to BYTE location 0
F8 and type 22< (? m 22<) displays 22 "command lines" of memory

Note the Auto-Start flags; arrow, 4, V, at byte location 0, 1, 2. Refer to lines1030,1040,1050. Followed by the first command, mode = O 80H; 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

Refer to the CY 545 MANUAL, SECTIONS 1-12,16, (see StepMotor and Home) 17,19 (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 motors in the customer application.

AUTO-START DEFEAT. To by-pass the auto-start, in the event an in-correct program is loaded to the memory, and/or the system locks-up in auto-start. Also refer to Section 12- 4 of the CY 545 manual.

A) Remove the cover of the controller, if present.
B) Locate the P- 2 pins (Auto-Start Lockout), see diagram in this manual.
C) Short the pins with a clip or jumper.
D) Reset the controller. Controller will by-pass the Auto-Start.
E) Remove the jumper. Re-start (SHIFT- F5) the demo and CLEAR or overwrite 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.

PROGRAMMING

The software program used with the MMC 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.
<u>NOTE: It is helpful to "read the listing" even for non-computer types.</u>

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 1000-1799 is the self-test EEPROM program. 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 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, (LOAD, CLEAR) at Line 2210-2270 which are created commands not part of the 545 command set. A$ is the current keyboard string.

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.

Reserved User Bits.

B 0 Enable Drivers; must be LO to step.
B 6 Bit 6 Is the Busy Bit option. See mOde Command.
[a,b,c] HP-LED command string is not used.

Reserved Software Commands. (Not CY 545 commands).

CLEAR Writes 0's and CR's to memory.
LOAD Loads memory. NOT same function as Basic F3 key.
EXIT See F5 key. Required to close comm port, close file, and clear error traps. Do not use ESC key. Use CTRL-BREAK keys to exit program that is locked in busy message loop.
comma Do not use comma to separate elements of 545 commands (T, L, and ? M xx) as comma is reserved for Basic; use space.

Special Aspects of Some Commands.

A In this multiple motor system, the 545 can not keep the position of more than one axis, therefore, if required, use the A command to reload the P counter with the last position of the selected channel.

W The Wait command causes the 545 to wait at the instruction, therefore incoming STOP (0 or CR's) 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.

HEX The commands T,H,W,B,O are followed by a numeric value in Hexdecimal which is desinated by the H following the value. The decimal and hex values for 0 to 7 are the same and the H is omitted. Note that the MODE command uses letters; any Hex value beginning with a letter must be preceded by a 0.

H Homing is a single stepping operation. The Busy signal is not continuously set during homing but cycles every step. It is best

therefore, that homing is executed from memory.

PROGRAM LISTINGS

```
5  PRINT              " MMC 4 CHANNEL DEMO     WITH I/O TEST      DEMO PROGRAM REV   10-18-93
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 "    :                     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=5000 386=10000 486=30000 TIME BASE VALUE
120 T0=50:                               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" 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,CS2000,DS0,CD0" AS #1  :REM  CS SET TO 1 SEC
145 PRINT #1,CR$;CR$;:                   REM SEND AUTOBAUD CARRIAGE RETURNS TO COM 1
150 REM  OPEN "COM2:1200,N,8,1,CS000,DS0,CD0" AS #2
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 "COM2:1200,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    :              REM REMOVE REM'S TO OPEN COM2    SEE LINE 2910
200 LOCATE 5,1,1
210 PRINT            " THE MOTION GROUP   FOUR MOTOR MOTION       MODEL MMC  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 LOCKOUT SWITCH
260 PRINT" SEE LINE 1000 FOR EEPROM PROGRAM - Y=000 AND Y=1000 I/O TEST
270 PRINT" USE CLEAR COMMAND TO ERASE EEPROM MEMORY
280 PRINT" USE LOAD COMMAND TO LOAD EEPROM MEMORY
290 PRINT" USE EXIT COMMAND TO EXIT THIS PROGRAM CORRECTLY
300 PRINT" BIT 0 ENABLES DRIVER  MUST BE LOW TO STEP
310 PRINT" BIT 1 IS DATA BIT ( INPUT OR OUTPUT )
320 PRINT" BIT 2, 3, 4 ARE MULTIPLEX ADDRESS BITS
330 PRINT" BIT 5 IS INPUT (READ) SELECT, BIT 7 IS OUTPUT (WRITE) SELECT
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"
380 PRINT"
390 PRINT"Note| Use RESET switch to STOP system. Always use F5 to EXIT program "
400 PRINT"    DOWN-LOAD SELF-TEST HOMING DEMO IN PROGRESS, BLOCK SENSORS
                    WAIT FOR P=000000          "
409 '
```

```
410 REM ********START OF INITIAL DOWNLOAD COMMANDS SELFTEST PROGRAM
500 REM  GOTO 1800:      REM  BYPASS SELFTEST, GOTO ENTER COMMAND PROMPT
501 REM  **********DOWN-LOAD DEMONSTRATION PROGRAM*****************************
502 PRINT #ACTIVE,"/B 7": GOSUB 2500: REM  WRITE OUTPUT PORT; CLEAR ALL OUTS
503 PRINT #ACTIVE,"B 1":  GOSUB 2500: REM  SET DATA BIT HI
504 PRINT #ACTIVE,"/B 2": GOSUB 2500
505 PRINT #ACTIVE,"/B 3": GOSUB 2500: REM  ADDRESS BITS =   B2  B3  B4  OUT BIT
506 PRINT #ACTIVE,"/B 4": GOSUB 2500: REM                  0   0   0   OUT 0
507 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                  1   0   0   OUT 1
508 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                  0
509 PRINT #ACTIVE,"B 3":  GOSUB 2500: REM                  0   1   0   OUT 2
510 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                  1   1   0   OUT 3
511 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                  0
512 PRINT #ACTIVE,"/B 3": GOSUB 2500: REM                      0
513 PRINT #ACTIVE,"B 4":  GOSUB 2500: REM                  0   0   1   OUT 4
514 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                  1   0   1   OUT 5
515 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                  0
```

```
516 PRINT #ACTIVE,"B 3":  GOSUB 2500: REM                  0   1   1   OUT 6
517 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                  1   1   1   OUT 7
OUTPUTS CLEARED
520 '
521 '
522 PRINT #ACTIVE,/B 0":   GOSUB 2500: REM *********OUTPUT ENABLE MOTOR DRIVERS
523 PRINT #ACTIVE,"/B 2":   GOSUB 2500: REM SELECT MOTOR 0
524 PRINT #ACTIVE,"/B 3":   GOSUB 2500: REM
525 PRINT #ACTIVE,"/B 4":   GOSUB 2500: REM
526 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM                   0   0    0  OUT 0
527 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM LATCH OUT PORT
528 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI FOR HOME INPUT
529 PRINT #ACTIVE,"/B 5":   GOSUB 2500: REM SELECT INPUT PORT
530 PRINT #ACTIVE,"F 100":  GOSUB 2500: REM FAST RATE FOR HOMING
535 PRINT #ACTIVE,"H 1":    GOSUB 2500: REM HOME MOTOR 0 ON B1
540 PRINT #ACTIVE,"F 30":   GOSUB 2500: REM MOVE RATE FOR MOTOR TEST
541 PRINT #ACTIVE,"P 800":  GOSUB 2500: REM MOVE OUT TO POSITION 1000
542 PRINT #ACTIVE,"P 0":    GOSUB 2500:  REM  MOVE BACK TO POSITION 0
543 PRINT #ACTIVE,"P 1600": GOSUB 2500
544 PRINT #ACTIVE,"P 0":    GOSUB 2500
545 PRINT #ACTIVE,"P 3200": GOSUB 2500
546 PRINT #ACTIVE,"P 0":    GOSUB 2500
547 PRINT #ACTIVE,"P 6400": GOSUB 2500
548 PRINT #ACTIVE,"P 0":    GOSUB 2500
549 PRINT #ACTIVE,"P 8000": GOSUB 2500
550 PRINT #ACTIVE,"P 0":    GOSUB 2500
551 PRINT #ACTIVE,"P 10000":GOSUB 2500
552 PRINT #ACTIVE,"P 0":    GOSUB 2500
553 PRINT #ACTIVE,"B 5":    GOSUB 2500: REM DESELECT IN PORT     0   0   0   IN 0

556 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM WRITE OUT PORT  DESELECTS MOTOR 0
557 PRINT #ACTIVE,"B 2":    GOSUB 2500: REM SELECT MOTOR 1       1   0   0   OUT 1
558 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM SET B1 LO
559 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM LATCH OUT PORT       1   0   0   OUT 1
560 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM HOME
561 PRINT #ACTIVE,"/B 5":   GOSUB 2500: REM SELECT HOME INPUT  1   0   0   IN 1
562 PRINT #ACTIVE,"F 100":  GOSUB 2500: REM FAST RATE FOR HOMING
563 PRINT #ACTIVE,"H 1":    GOSUB 2500: REM HOME MOTOR 1 ON B1
564 PRINT #ACTIVE,"F 30":   GOSUB 2500: REM MOVE RATE FOR MOTOR TEST
565 PRINT #ACTIVE,"P 800":  GOSUB 2500:
566 PRINT #ACTIVE,"P 0":    GOSUB 2500
567 PRINT #ACTIVE,"P 1600": GOSUB 2500
568 PRINT #ACTIVE,"P 0":    GOSUB 2500
569 PRINT #ACTIVE,"P 4800": GOSUB 2500
570 PRINT #ACTIVE,"P 0":    GOSUB 2500
572 PRINT #ACTIVE,"P 9600": GOSUB 2500
577 PRINT #ACTIVE,"P 0":    GOSUB 2500
578 PRINT #ACTIVE,"B 5":    GOSUB 2500: REM DESELECT IN PORT
580 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI
581 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM DESELECTS MOTOR 1   1   0   0   OUT 1
605 PRINT #ACTIVE,"/B 2":   GOSUB 2500: REM
606 PRINT #ACTIVE,"B 3":    GOSUB 2500: REM SELECT MOTOR 2          0   1   0
607 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM SET B1 LO
608 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM WRITE OUTPUT LATCH   0   1   0   OUT 2
```

```
609 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI
611 PRINT #ACTIVE,"/B 5":   GOSUB 2500: REM SELECT HOME INPUT      0   1   0   IN 1
612 PRINT #ACTIVE,"F 100":  GOSUB 2500: REM FAST RATE FOR HOMING
613 PRINT #ACTIVE,"H 1":    GOSUB 2500: REM HOME MOTOR 2 ON B1
614 PRINT #ACTIVE,"F 30":   GOSUB 2500: REM MOVE RATE FOR MOTOR TEST
615 PRINT #ACTIVE,"P 800":  GOSUB 2500
616 PRINT #ACTIVE,"P 0":    GOSUB 2500
617 PRINT #ACTIVE,"P 1600": GOSUB 2500
618 PRINT #ACTIVE,"P 0":    GOSUB 2500
619 PRINT #ACTIVE,"P 4800": GOSUB 2500
620 PRINT #ACTIVE,"P 0":    GOSUB 2500
622 PRINT #ACTIVE,"P 9600": GOSUB 2500
627 PRINT #ACTIVE,"P 0":    GOSUB 2500
```

```
628 PRINT #ACTIVE,"B 5":    GOSUB 2500: REM
730 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM
731 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM DESELECT MOTOR 2
732 PRINT #ACTIVE,"B 2":    GOSUB 2500: REM SELECT MOTOR 3          1
733 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM
734 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM LATCH MOTOR 3           1   1   0   OUT 3
737 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM
738 PRINT #ACTIVE,"/B 5":   GOSUB 2500: REM SELECT INPUT PORT      1   1   0   IN 3
760 PRINT #ACTIVE,"F 100":  GOSUB 2500: REM FAST RATE FOR HOMING
761 PRINT #ACTIVE,"H 1":    GOSUB 2500: REM HOME MOTOR 3 ON B1
762 PRINT #ACTIVE,"F 30":   GOSUB 2500: REM MOVE RATE FOR MOTOR TEST
763 PRINT #ACTIVE,"P 800":  GOSUB 2500
764 PRINT #ACTIVE,"P 0":    GOSUB 2500
765 PRINT #ACTIVE,"P 1600": GOSUB 2500
766 PRINT #ACTIVE,"P 0":    GOSUB 2500
767 PRINT #ACTIVE,"P 4800": GOSUB 2500
768 PRINT #ACTIVE,"P 0":    GOSUB 2500
769 PRINT #ACTIVE,"P 9600": GOSUB 2500
770 PRINT #ACTIVE,"P 0":    GOSUB 2500
771 PRINT #ACTIVE,"B 5":    GOSUB 2500
775 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM DESELECT 3                  1   1   0   OUT 3
776 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM CLOSE OUT PORT
780 PRINT #ACTIVE,"B 0":    GOSUB 2500: REM DISABLE MOTORS
810 GOTO 1800 :                     REM    GO TO ENTER COMMAND PROMPT
820 '
830 '
1000 '    ********** SAMPLE PROGRAM - EEPROM  MEMORY  ********************
1001 '    *********  Modify the commands between the quotes    ****************
1002 '    *********  Modify the commands between the quotes    ****************
1003 '    *********  Modify the commands between the quotes    ****************
1010 PRINT #ACTIVE,"Y 0": T=T0: GOSUB 2500:         REM EEPROM START ADDRESS
1011 REM T=T0 delay,    required between commands for EEPROM's 10 MS write time
1020 PRINT #ACTIVE,"E":             GOSUB 2500: REM Enter programming mode {save to EEPROM}

1030 PRINT #ACTIVE,CHR$(18);: GOSUB 2500: REM POWER ON FLAG  12H - ADDRESS 00
1040 PRINT #ACTIVE,CHR$(52);: GOSUB 2500: REM POWER ON FLAG  34H - ADDRESS 01
1050 PRINT #ACTIVE,CHR$(86);: GOSUB 2500: REM POWER ON FLAG  56H - ADDRESS 02

1060 PRINT #ACTIVE,"O 80H":     GOSUB 2500:
1061 REM  * NOTE * Line 1060 sets system busy {BIT 6} to lock out CPU commands during
                CY 545 program execution.  See Mode {O} Command.
1070 PRINT #ACTIVE,"/B 7":    GOSUB 2500: REM SELECT OUTPUT PORT; CLEAR ALLOUTS
1080 PRINT #ACTIVE,"B 1":     GOSUB 2500: REM  SET DATA BIT HI
1090 PRINT #ACTIVE,"/B 2":    GOSUB 2500
1100 PRINT #ACTIVE,"/B 3":    GOSUB 2500: REM  ADDRESS BITS =  B2  B3  B4
1110 PRINT #ACTIVE,"/B 4":    GOSUB 2500: REM                  0   0   0   OUT 0
1120 PRINT #ACTIVE,"B 2":     GOSUB 2500: REM                  1   0   0   OUT 1
1130 PRINT #ACTIVE,"/B 2":    GOSUB 2500: REM                  0
1140 PRINT #ACTIVE,"B 3":     GOSUB 2500: REM                  0   1   0   OUT 2
1150 PRINT #ACTIVE,"B 2":     GOSUB 2500: REM                  1   1   0   OUT 3
1160 PRINT #ACTIVE,"/B 2":    GOSUB 2500: REM                  0
1170 PRINT #ACTIVE,"/B 3":    GOSUB 2500: REM                     0
1180 PRINT #ACTIVE,"B 4":     GOSUB 2500: REM                  0   0   1   OUT 4
1190 PRINT #ACTIVE,"B 2":     GOSUB 2500: REM                  1   0   1   OUT 5
```

```
1200 PRINT #ACTIVE,"/B 2":    GOSUB 2500: REM                0
1210 PRINT #ACTIVE,"B 3":     GOSUB 2500: REM                0   1   1   OUT 6
1220 PRINT #ACTIVE,"B 2":     GOSUB 2500: REM  CLEARED 1   1   1   OUT 7

1230 PRINT #ACTIVE,"/B 0":    GOSUB 2500: REM  OUTPUT ENABLE MOTOR DRIVERS
1240 PRINT #ACTIVE,"/B 2":    GOSUB 2500: REM ADDRESS MOTOR 0
1250 PRINT #ACTIVE,"/B 3":    GOSUB 2500: REM
1260 PRINT #ACTIVE,"/B 4":    GOSUB 2500: REM                  0   0    0  OUT 0
1270 PRINT #ACTIVE,"/B 1":    GOSUB 2500: REM SET MOTOR 0 BIT L  (B1 = LO)
1280 PRINT #ACTIVE,"B 7":     GOSUB 2500: REM WRITE OUTPUT PORT
1290 PRINT #ACTIVE,"B 1":     GOSUB 2500: REM SET B1 HI
1320 PRINT #ACTIVE,"P 1000": GOSUB 2500: REM MOVE OUT TO POSITION 1000
1321 PRINT #ACTIVE,"P 0":      GOSUB 2500:  REM  MOVE BACK TO POSITION 0
1322 PRINT #ACTIVE,"P 1000": GOSUB 2500
1323 PRINT #ACTIVE,"P 0":      GOSUB 2500
1324 PRINT #ACTIVE,"P 1000": GOSUB 2500
1325 PRINT #ACTIVE,"P 0":      GOSUB 2500
```

```
1326 PRINT #ACTIVE,"P 1000": GOSUB 2500
1327 PRINT #ACTIVE,"P 0":    GOSUB 2500
1328 PRINT #ACTIVE,"P 1000": GOSUB 2500
1329 PRINT #ACTIVE,"P 0":    GOSUB 2500
1330 PRINT #ACTIVE,"P 2000": GOSUB 2500
1340 PRINT #ACTIVE,"P 0":    GOSUB 2500
1360 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM WRITE OUT PORT DESELECTS MOTOR 0
1370 PRINT #ACTIVE,"B 2":    GOSUB 2500: REM SELECT MOTOR 1      1   0   0   OUT 1
1380 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM SET BIT 1 LO
1390 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM WRITE OUT LATCH     1   0   0   OUT 1
1400 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI
1420 PRINT #ACTIVE,"P 1000": GOSUB 2500
1421 PRINT #ACTIVE,"P 0":    GOSUB 2500
1422 PRINT #ACTIVE,"P 1000": GOSUB 2500
1423 PRINT #ACTIVE,"P 0":    GOSUB 2500
1424 PRINT #ACTIVE,"P 1000": GOSUB 2500
1425 PRINT #ACTIVE,"P 0":    GOSUB 2500
1426 PRINT #ACTIVE,"P 1000": GOSUB 2500
1427 PRINT #ACTIVE,"P 0":    GOSUB 2500
1428 PRINT #ACTIVE,"P 1000": GOSUB 2500
1429 PRINT #ACTIVE,"P 0":    GOSUB 2500
1430 PRINT #ACTIVE,"P 2000": GOSUB 2500
1440 PRINT #ACTIVE,"P 0":    GOSUB 2500: REM
1470 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM WRITE OUT PORT DESELECTS MOTOR1
1510 PRINT #ACTIVE,"/B 2":   GOSUB 2500: REM ADDRESS MOTOR 2     0
1520 PRINT #ACTIVE,"B 3":    GOSUB 2500: REM                        1
1540 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM SET MOTOR 0 BIT LO (B1 = LO)
1550 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM WRITE OUT PORT         0   1   0   OUT 2
1560 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI
1570 PRINT #ACTIVE,"P 1000": GOSUB 2500: REM MOVE OUT TO POSITION 1000
1571 PRINT #ACTIVE,"P 0":    GOSUB 2500:  REM  MOVE BACK TO POSITION 0
1572 PRINT #ACTIVE,"P 1000": GOSUB 2500
1573 PRINT #ACTIVE,"P 0":    GOSUB 2500
1574 PRINT #ACTIVE,"P 1000": GOSUB 2500
1575 PRINT #ACTIVE,"P 0":    GOSUB 2500
1576 PRINT #ACTIVE,"P 1000": GOSUB 2500
1577 PRINT #ACTIVE,"P 0":    GOSUB 2500
1578 PRINT #ACTIVE,"P 1000": GOSUB 2500
1579 PRINT #ACTIVE,"P 0":    GOSUB 2500
1600 PRINT #ACTIVE,"P 2000": GOSUB 2500
1610 PRINT #ACTIVE,"P 0":    GOSUB 2500
1620 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM WRITE OUT PORT [DESELECTS MOTOR 2]
1630 PRINT #ACTIVE,"B 2":    GOSUB 2500: REM SELECT MOTOR 3      1
1640 PRINT #ACTIVE,"/B 1":   GOSUB 2500: REM SET BIT 1 LO
1650 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM LATCH OUTPUT          1   1   0   OUT 3
1660 PRINT #ACTIVE,"B 1":    GOSUB 2500: REM SET B1 HI
1670 PRINT #ACTIVE,"P 1000": GOSUB 2500
1671 PRINT #ACTIVE,"P 0":    GOSUB 2500
1672 PRINT #ACTIVE,"P 1000": GOSUB 2500
1673 PRINT #ACTIVE,"P 0":    GOSUB 2500
1674 PRINT #ACTIVE,"P 1000": GOSUB 2500
1675 PRINT #ACTIVE,"P 0":    GOSUB 2500
1676 PRINT #ACTIVE,"P 1000": GOSUB 2500
1677 PRINT #ACTIVE,"P 0":    GOSUB 2500
```

```
1678 PRINT #ACTIVE,"P 1000": GOSUB 2500
1679 PRINT #ACTIVE,"P 0":    GOSUB 2500
1680 PRINT #ACTIVE,"P 2000": GOSUB 2500
1681 PRINT #ACTIVE,"P 0":    GOSUB 2500: REM END OF MOTOR TEST
1682 PRINT #ACTIVE,"/B 7":   GOSUB 2500: REM WRITE OUT PORT DESELECTS MOTOR 3
1683 PRINT #ACTIVE,"B 7":    GOSUB 2500: REM LATCH OUTPUT PORT (B1 IS HI)
1684 PRINT #ACTIVE,"B 0":    GOSUB 2500: REM SET B0 HI - DISABLE MOTORS
1686 PRINT #ACTIVE,"O 0A0H": GOSUB 2500: REM Return to handshake mode
1688 PRINT #ACTIVE,"0":      GOSUB 2500: REM Stop. Return to Direct mode
1690 PRINT #ACTIVE,"Q":      GOSUB 2500: REM Quit programming mode
1700 '
1701 '
1702 '
1703 '***************I/O TEST*****************************************************
1704 PRINT #ACTIVE,"Y 1000": T=T0: GOSUB 2500: REM I/O TEST
1705 PRINT #ACTIVE,"E":    GOSUB 2500: REM Enter programming mode;save to EEPROM
1708 PRINT #ACTIVE,"B 1":  GOSUB 2500: REM
```

```
1709 PRINT #ACTIVE,"B 7":  GOSUB 2500: REM
1710 PRINT #ACTIVE,"/B 5": GOSUB 2500: REM
1719 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                          0
1720 PRINT #ACTIVE,"/B 3": GOSUB 2500: REM                             0
1721 PRINT #ACTIVE,"B 4":  GOSUB 2500: REM                          0   0   1  IN 4
1722 PRINT #ACTIVE,QT$+"WAITING ON IN 4 LOW  "+QT$+"W 11H": GOSUB 2500:
1725 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                          1   0   1  IN 5
1731 PRINT #ACTIVE,QT$+"WAITING ON IN 5 LOW  "+QT$+"W 11H": GOSUB 2500:
1734 PRINT #ACTIVE,"B 3":  GOSUB 2500: REM                             1
1735 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                          0   1   1  IN 6
1736 PRINT #ACTIVE,QT$+"WAITING ON IN 6 LOW  "+QT$+"W 11H": GOSUB 2500:
1737 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                          1   1   1  IN 7
1738 PRINT #ACTIVE,QT$+"WAITING ON IN 7 LOW  "+QT$+"W 11H": GOSUB 2500:
1739 PRINT #ACTIVE,"B 5":  GOSUB 2500: REM **********DESELECT INPUT PORT
1750 PRINT #ACTIVE,"/B 7": GOSUB 2500: REM SELECT OUTPUT PORT; TEST OUTPUTS
1751 PRINT #ACTIVE,"/B 1": GOSUB 2500: REM SET DATA BIT LO      1   1   1   OUT 7
1752 PRINT #ACTIVE,"D 900":GOSUB 2500: REM DELAY 900 MS
1753 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                          0   1   1   OUT 6
1754 PRINT #ACTIVE,"D 900":GOSUB 2500: REM DELAY
1755 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                          1
1756 PRINT #ACTIVE,"/B 3": GOSUB 2500: REM                          1   0   1   OUT 5
1758 PRINT #ACTIVE,"D 900":GOSUB 2500: REM DELAY
1760 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                          0   0   1   OUT 4
1761 PRINT #ACTIVE,"D 900":GOSUB 2500: REM DELAY
1769 PRINT #ACTIVE,"B 1":  GOSUB 2500: REM CLEAR OUTPUTS
1773 PRINT #ACTIVE,"B 4":  GOSUB 2500: REM                          0   0   1   OUT 4
1774 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                          1   0   1   OUT 5
1775 PRINT #ACTIVE,"/B 2": GOSUB 2500: REM                          0
1776 PRINT #ACTIVE,"B 3":  GOSUB 2500: REM                          0   1   1   OUT 6
1777 PRINT #ACTIVE,"B 2":  GOSUB 2500: REM                          1   1   1   OUT 7
1778 PRINT #ACTIVE,"B 7":  GOSUB 2500: REM DESELECT OUTPUT PORT
1794 PRINT #ACTIVE,QT$+"END OF SELF TEST  "+QT$+"D 1": GOSUB 2500: REM
1795 PRINT #ACTIVE,"? B":  GOSUB 2500: REM TEST COMM
1798 PRINT #ACTIVE,"0":    GOSUB 2500: REM Stop. Return to Direct mode
1799 PRINT #ACTIVE,"Q":    GOSUB 2500: REM Quit programming mode

1800 A$="? P": T=T0: REM Query Position - Indicates completed LOAD sequence
1810 GOTO 2280:      REM  Send 'QUERY  POSITION' to comm port

2000 REM******ENTER COMMAND AND READ KEYBOARD*******************************
2010 A$="" : LOCATE ,,1 :                        REM DRAW CURSOR  AT CURRENT POSITION
2020 PRINT "  ENTER COMMAND> ";A$;
2030 CH$=INKEY$ :                                REM READ KEYBOARD
2040 IF CH$ = ES$ THEN PRINT CR$; : GOTO 2010 :     REM HANDLE ESCAPE
2050 IF CH$ <> 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$)-1) :           REM OTHERWISE, HANDLE BACKSPACE
2080 Y=CSRLIN :                                  REM CURRENT CURSOR LINE
2090 X=POS(0) :                                  REM CURRENT CURSOR COLUMN
2100 LOCATE Y,X-1 :                              REM MOVE BACK ONE SPACE
2110 PRINT " "; :                                REM PRINT OUT PREVIOUS   BLINK  NO CR
2120 LOCATE Y,X-1 :                              REM MOVE BACK ONE SPACE
2130 GOTO 2030 :                                 REM CLEAR T AND EL COUNTER
2140 IF CH$<>"" THEN PRINT CH$;
```

```
2150 IF CH$<>CR$ THEN A$=A$+CH$ ELSE GOTO 2200 :   REM BUILD COMMAND TIL CR
2160 IF EOF(ACTIVE) GOTO 2030 :                    REM LOOP TO 2030 IF COM IS NOT ACTIVE
2170 PRINT CR$; :                                  REM MOVE DOWN LINE FOR COM DATA
2180 GOSUB 2600 :                                  REM PRINT RECEIVED DATA ON NEW LINE
2190 GOTO 2020 :                                   REM CONTINUE COMMAND ENTRY
2200 KEY 10,A$+CR$:                                REM SAVE REPEAT KEY

2210 IF A$="EXIT" THEN GOTO 2910:                  REM CHECK FOR SPECIAL COMMANDS
2220 IF A$="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 PRINT COMMAND TO COM PORT
2290 GOSUB 2500:                                   REM DO TIME DELAY
```

```
2300 GOSUB 2600:                                REM CHECK COM PORT FOR DATA
2310 IF LEFT$(A$,1)="I" THEN A$=CR$: GOTO 2280:  REM WAS RESET COMMAND
2320 T=T0: EL=0:                                REM CLEAR T AND EL COUNTERS
2330 GOTO 2010:                                 REM RETURN TO ENTER COMMAND PROMPT
2500 FOR W=1 TO T: NEXT W:                      REM LOOP COUNTER
2510 RETURN:                                    REM RETURN TO CALLING SUBROUTINE

2600 REM ***** READ DATA FROM ACTIVE COM PORT **********************************
2610 B$="":                                     REM DEFINE INPUT FROM COM AS B$
2620 WHILE NOT EOF(ACTIVE):     REM IF EOF=1(EMPTY) GOTO 2730 IF EOF=0 GET DATA
2630 J%=LOC(ACTIVE) : B$=B$+INPUT$(J%,#ACTIVE) : REM J%=LOCATION POINTER - B$=INPUT STRING
2640 IF MID$(B$,9,1)=CHR$(255) THEN B$="" : E=1: GOTO 2660: REM MEM EMPTY ERROR
2650 GOTO 2700:                 REM RESET E FLAG
2660 IF E=1 THEN LOCATE 23,1: PRINT " MEMORY EMPTY ERROR . . . PLEASE PERFORM HARDWARE RESET
OF DRIVER,  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 DELAY FOR MORE COM DATA
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 COM WAS MEMORY 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 : PRINT " NOTE . . . .  THIS ROUTINE WILL ERASE ALL DATA IN THE EEPROM MEMORY!" : PRINT
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 "   *****      EXIT AND RERUN 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
```

SERIAL CABLES

Note : DB-9 Controller is wired as a Null Modem

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**
PIN 5	**CTS Clear**	**<---------- **	**PIN 8 DSR Ready**
PIN 7	**Signal Ground**	**<----------> **	**PIN 5 Signal/Frame**

DB-25 to DB-9 ADAPTOR

Note: Some DB-25 to DB-9 plugs are not standard; verify above before using!!

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

PIN 3	**TX Transmit**	**----------> **	**PIN 3 RX Receive**
PIN 2	**RX Receive**	**<---------- **	**PIN 2 TX Transmit**
PIN 8	**CTS Cleared**	**<---------- **	**PIN 8 DSR Ready**
PIN 5	**Signal Ground**	**<----------> **	**PIN 5 Signal/Frame**
PIN 4	**DTR Ready**	**----------> **	**PIN 4 DTR Hand In**
PIN 1	**CD not used**	**<-terminal supply-- **	**PIN 1 +5 vdc supply**
Shell	**Frame Ground**	**<----------> **	**Shell Signal/Frame**

PIN to PIN CABLE

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**
PIN 1	**RTS Ready**	**----------> **	**PIN 4 DTR Hand In**
PIN 8	**RX In+ (GND)**	**<----------' **	**Shell Signal/Frame**
Shell	**Frame Ground**	**<----------'----------> **	**Shell Signal/Frame**

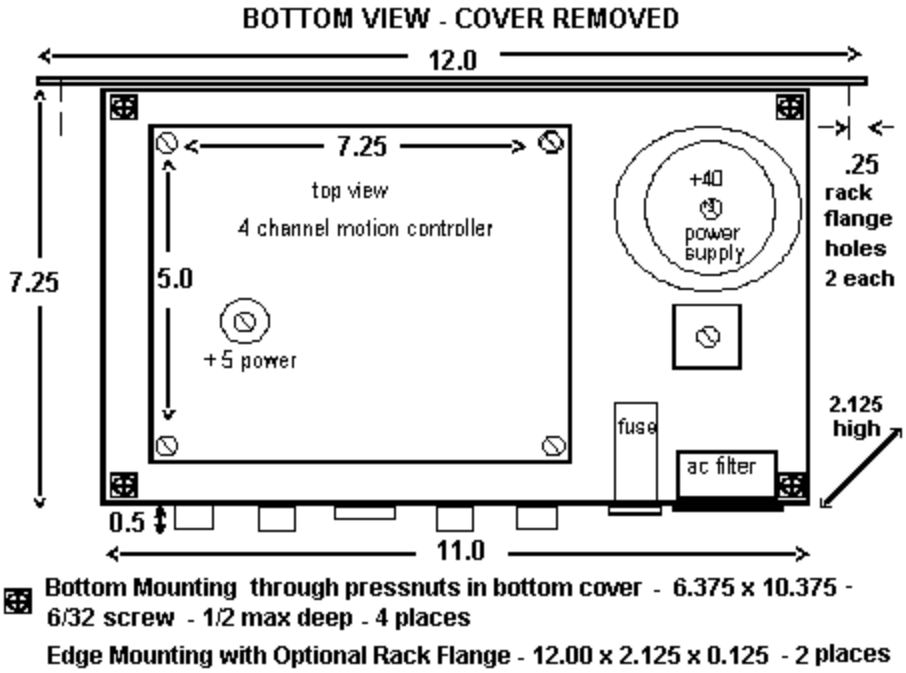
MAC to IBM ADAPTOR CABLE

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.

The DTR signal is used to Auto-Reset if the host CPU exits the comm port.

SMD SECTION 2



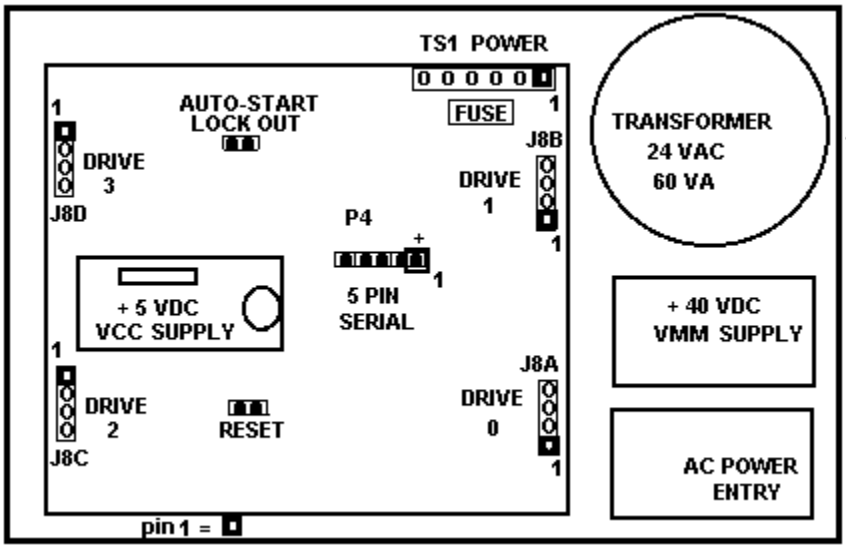
The SMD assembly consists of a MMC controller, all DC power supplies, and an AC power entry. The DC power supplies provide +5 vdc TTL computer (VCC) and +40 vdc motor (VMM). The VCC supply is over-current protected. The VMM supply is fused on the MMC card. In addition, a 1 amp AC fuse protects the entire assembly.

NOTE: NEVER REPLACE THE FUSE. A BLOWN FUSE INDICATES A DAMAGED DRIVER.

Normally, all four motor drivers are never selected at the same time as this would draw excessive current and pull the fuse(s). Use care when programming the system to prevent this event. The green LED located next to the on-board fuse and the green chassis lamp indicate VMM power on. The neon lamp in the power switch indicates that AC power is present to the SMD.
The MMC card has 4 motor connectors (see Appendix D), 1 power connector (see diagram below), 1 serial connector (refer to serial cable section), and LED status indicators. Two additional pin connectors are provided. The reset pins (P4), when shorted, will reset the system. The lock-out pins (P4), when shorted with the clip, will prevent the auto-start. The Px1 connectors consist of 4 CI cable sockets, one for each motor channel, which provide limits and home sensor signals. The 20 pin I/O connector provides access to the spare I/O lines and VCC power/ground. The wiring of the I/Os depends on the version of the MMC card; refer to Appendix A of Section Three of this manual.

SMD ASSEMBLY TOP VIEW

CARD CONNECTOR PINOUTS



CARD CONNECTORS

POWER

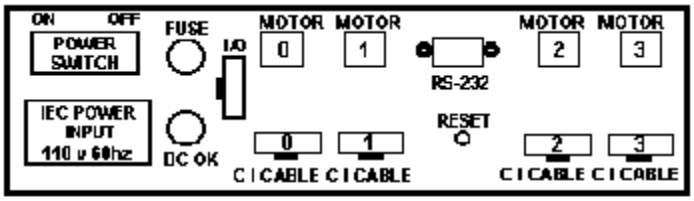
TS1-1 + 40 VMM
TS1-2 GND
TS1-3 GND
TS1-4 + 5 VCC
TS1-5 KEY
TS1-6 + 40 VMM

MOTORS

J8 - A B C D

J - 1 COIL A
J - 2 COIL A -
J - 3 COIL B
J - 4 COIL B -

SMD ASSEMBLY FRONT PANEL



SERIAL P 4

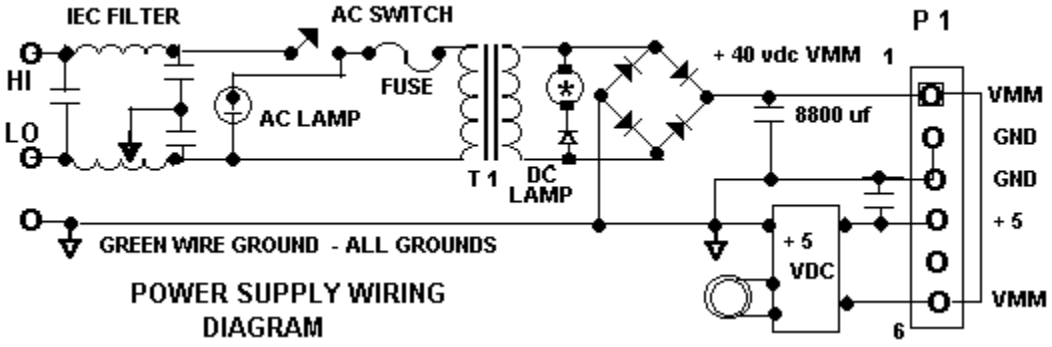
P4 - 1 + 5 VDC
P4 - 2 TX
P4 - 3 GND
P4 - 4 RX
P4 - 5 CTS

RESET P 3

P3 - 1 + 5 VDC
P3 - 2 RESET 545

For CI cable pin-out See Appendix A & F
For Current Adjust See Appendix C
For Motor Connects See Appendix D & E

SMD ASSEMBLY POWER SUPPLY WIRING DIAGRAM



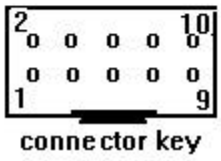
APPENDIX A: CI CABLE DIAGRAM FOR MMC SYSTEMS

☐ = MOLEX PIN #

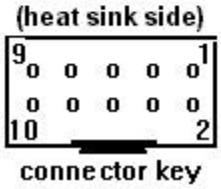
10: HOME SENSOR VCC +5	1	9: HOME SENSOR LED ANODE +	2
8: SENSOR AND LED GND	3	7: HOME SENSOR OUTPUT	4
6: USER VCC +5	1	5: USER GND	2
4: CW LIMIT INPUT	3	3: CCW LIMIT INPUT	4
2: ABR LOOP IN *LIMIT GND	1	1: ABR LOOP OUT *LIMIT GND	2

*CCW/CW Limits or Jog options only: Pins 2&1 must connected (ABR Loop closed) and B0 rmust be LO for pins 2&1 to be grounds.

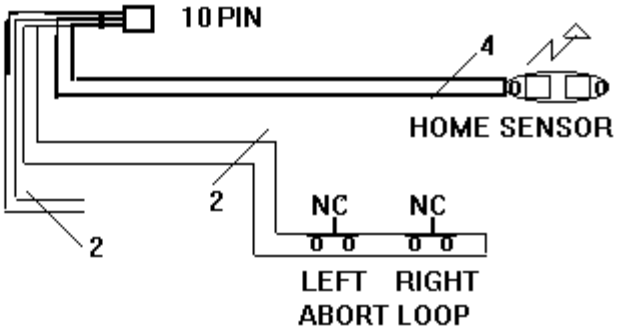
C I CABLE
10 PIN
FRONT PANEL
CONNECTOR

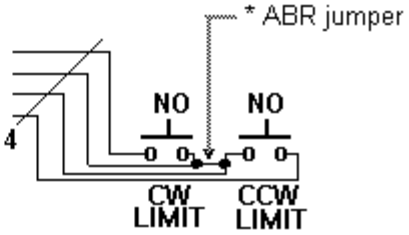


C I CABLE
10 PIN
PC CARD
CONNECTOR



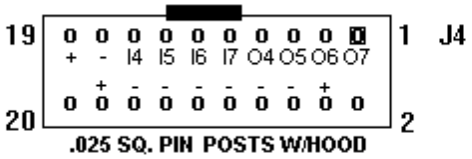
C I CABLE
(TYPICAL)





I/O CONNECTOR CABLE DIAGRAM FOR MMC - 20 PIN AND 10 PIN

20 PIN I/O
PC CARD
CONNECTOR
PINOUT

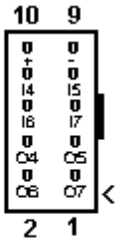


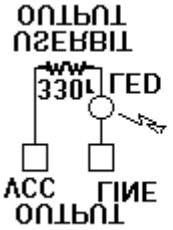
20	= SPARE	10	= GND	19	= +5vdc	9	= IN 7
18	= +5vdc	8	= GND	17	= GND	7	= OUT 4
16	= GND	6	= GND	15	= IN 4	5	= OUT 5
14	= GND	4	= +5vdc	13	= IN 5	3	= OUT 6
12	= GND	2	= SPARE	11	= IN 6	1	= OUT 7

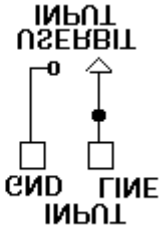
FRONT PANEL
10 PIN I/O
CONNECTOR

5 = IN 7	GRN	10 = +5VDC	BLK
4 = OUT 4	YEL	9 = GND	WHT
3 = OUT 5	ORN	8 = IN 4	GRY
2 = OUT 6	RED	7 = IN 5	PUR
1 = OUT 7	BRN	6 = IN 6	BLU

(SAME AS PIN 1-19 OF 20 PIN HEADER)







WARNING: UNPROTECTED I / O. NEVER CONNECT TO ANY POTENTIAL EXCEPT SYSTEM GROUND WITHOUT OPTICAL ISOLATION. CURRENT GROUND LOOPS WILL DAMAGE SYSTEM.

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

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

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

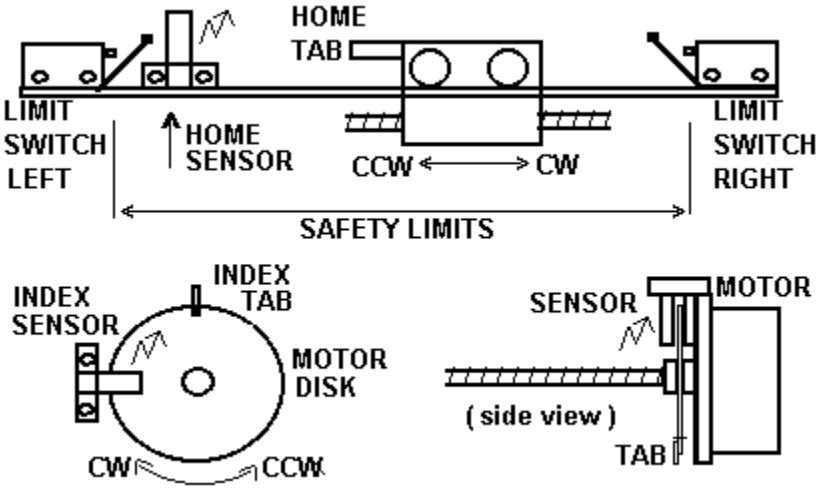
CENTER HOME AND CONTIGUOUS SLIP DETECTION. If the home sensor is located at the center of axis motion and a step bar is mounted along the entire motion path, then the home position can be verified each time the system crosses the center line. A stepped bar is thin strip with a left high side and a right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

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

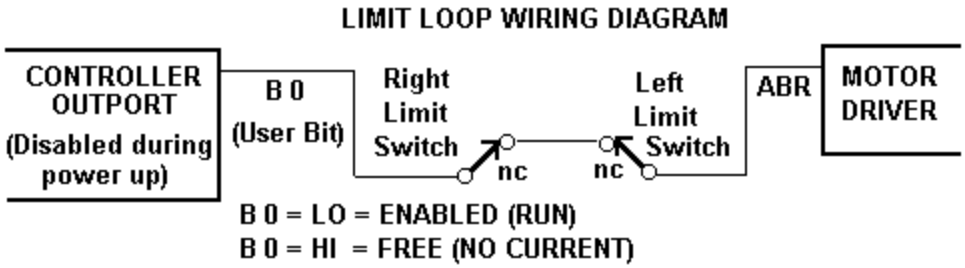
Lash compensation adds or subtracts steps, at each change of direction or because of other forces, to take-up the lash error. Lash compensation is accomplished during the slip-detection process. When the system is slip-detected the first time, the sensor will not close at position 0 because of the lash;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

Screw distortion error occurs when the screw pitch, which is so many turns per inch, does not move the correct distance after the correct number of turns of the motor. For example, a 10 turn screw should cause linear travel of 1 inch every 2000 steps (200 step/rev motor). If, rather than commanding the motor controller to go in 2000 step increments, the controller moves to absolute positions such as 2000, 4001, 6003, 7999, ect.; the error is eliminated. 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: MOTOR CURRENT ADJUSTMENT MM 2.0 (2 AMP MAX) SERIES

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

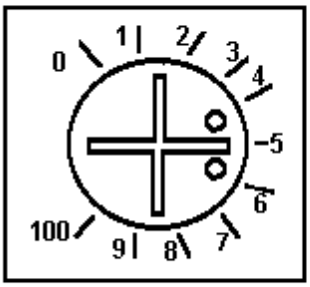
IN GENERAL:

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

BOARD EDGE →

PERCENTAGE OF MAXIMUM POWER →

MIN



MAX

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

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

APPENDIX D MOTOR WIRING SCHEMES PAGE 1/2

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

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

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

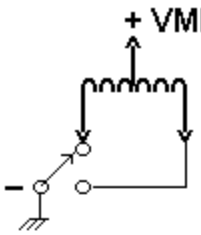
A: SINGLE COILS. Identical to unipolar specification (if the supply voltage equals the specified motor voltage). Normal connection of a bipolar driver to 6 wire motor.
B & D: SERIES COILS. This configuration will produce torque greater than the unipolar specification indicates. To stay within the power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

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

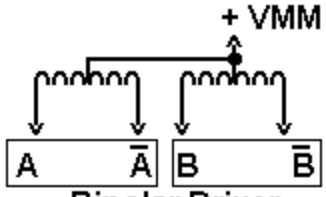
NOTES: If a motor runs "backwards" with respect to software direction, transpose the connections of ONE coil. For MS series driver cards, pins 2 & 3 or 6 & 7; SID / SMD driver boxes, pins 1 & 3 or $ & 6.

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

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

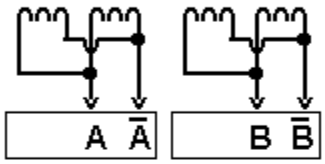


Typical Motor Winding
Unipolar Drive
[only 1/2 motor shown]



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

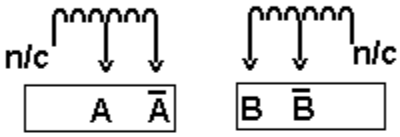
8 Wire - Parallel Coils



Best Speed - Best Torque

Fig. C

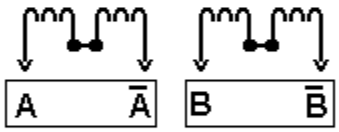
6 Wire - Single Coils



Normal Speed & Torque

Fig. A

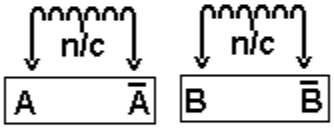
8 Wire - Series Coils



Low Speed - High Torque

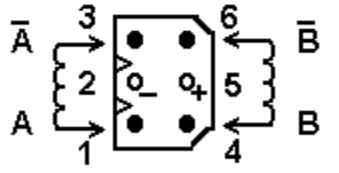
Fig. D

6 Wire - Series Coils

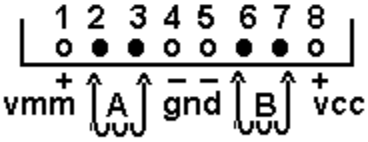


Low Speed - High Torque

Fig. B



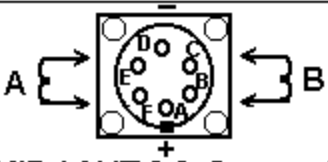
SMD / SID 2/4 Connector



MS/MM Card Connector

MOTION GROUP MOTOR CONNECTORS

SMD / SID HD Connector



MID / ANT 2.0 Connector

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MOLEX - WALDOM NYLON CONNECTOR SYSTEM USED BY THE MOTION GROUP

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

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

(Strain Relief Hoods are available on request)

Contacts for Connector Sets .062 SIZE

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

Contacts for Connector Sets .093 SIZE

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

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

Tooling

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

Nylon Connector Designer/Service Kit

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

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

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

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

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

SPECIFICATIONS - MMC 2.0 with MM2.0 Drivers

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

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

Environmental				
Operating temperature	-20	+50	C	
Humidity (non-condensing)		0	95	%
Shock		100		G
Altitude		30.000		FT
Mechanical				
Weight		5		lb
Dimensions (overall w/flange)		12" x 7.25" x 2.125" High		
Mounting hole centers		6.375" x 10.375" Sq. (bottom mounting)		
Mounting hole centers		11.25" centers (edge mount flange)		
Mounting screw size		#6-32 x 1/2" max.		

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