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Part #: 903-050001-02

Indexing Software

option code - 02

Programming Manual

for use with SC 150/SC450 Servo controllers
(Scanned and OCRed 05-23-05)

MC500 Motion Control Card oftware Instruction Manual Indexing Software TABLE OF CONTENTS

SECTION 1

INTRODUCTION

1.1 General

This manual outlines Installation/Set-up, Troubleshooting, and Programming procedures for IMEC Corporation's MC500 Series Motion Control Card with Indexing Version software. It also contains specifications.

The MC500 Motion Control Card is offered as an option on IMEC's SC100 and SC400 Series Brushless Servo Controllers. The card is specifically designed to integrate easily with these IMEC products, eliminating the need for any external hardware as well as eliminating interface and interconnection headaches. The microprocessor-based card adds higher level motion control functions to the host servo controller.

The MC500 is integrated with the servo controller at the factory. For proper installation and operation, this manual along with the appropriate SC150 or SC450 Brushless Servo Controller manual should be reviewed.

The MC500 is available with various software packages, each package intended for use in a specific class of applications. This manual describes the Indexing Software of the MC500. This version is intended for simple indexing applications. Up to 8 individual moves can be programmed. All moves are incremental and follow a trapezoidal velocity profile. Three index modes are available which allow simple indexing or indexing based upon a registration mark input.

1.2 Features

- Microprocessor-based design for reliability, flexibility, and digital precision
- Non-volatile memory (2 to 8K] for storage of parameters and motion profiles
- 8 discrete inputs and 8 discrete outputs which can be directly interfaced with OPTO 22 I/O modules
- RS-232 and RS-422/RS-485 serial communications ports Cost-effective single resolver feedback for reliable, rugged operation
- Following error detection system protects against motor runaways and load jams
- "Watchdog" timer circuit monitors microprocessor operation
- Built-in test modes aid in final system integration and system fault diagnostics
- Storage of up to 8 individual moves
- Trapezoidal velocity profile
- All profile parameters are user programmable

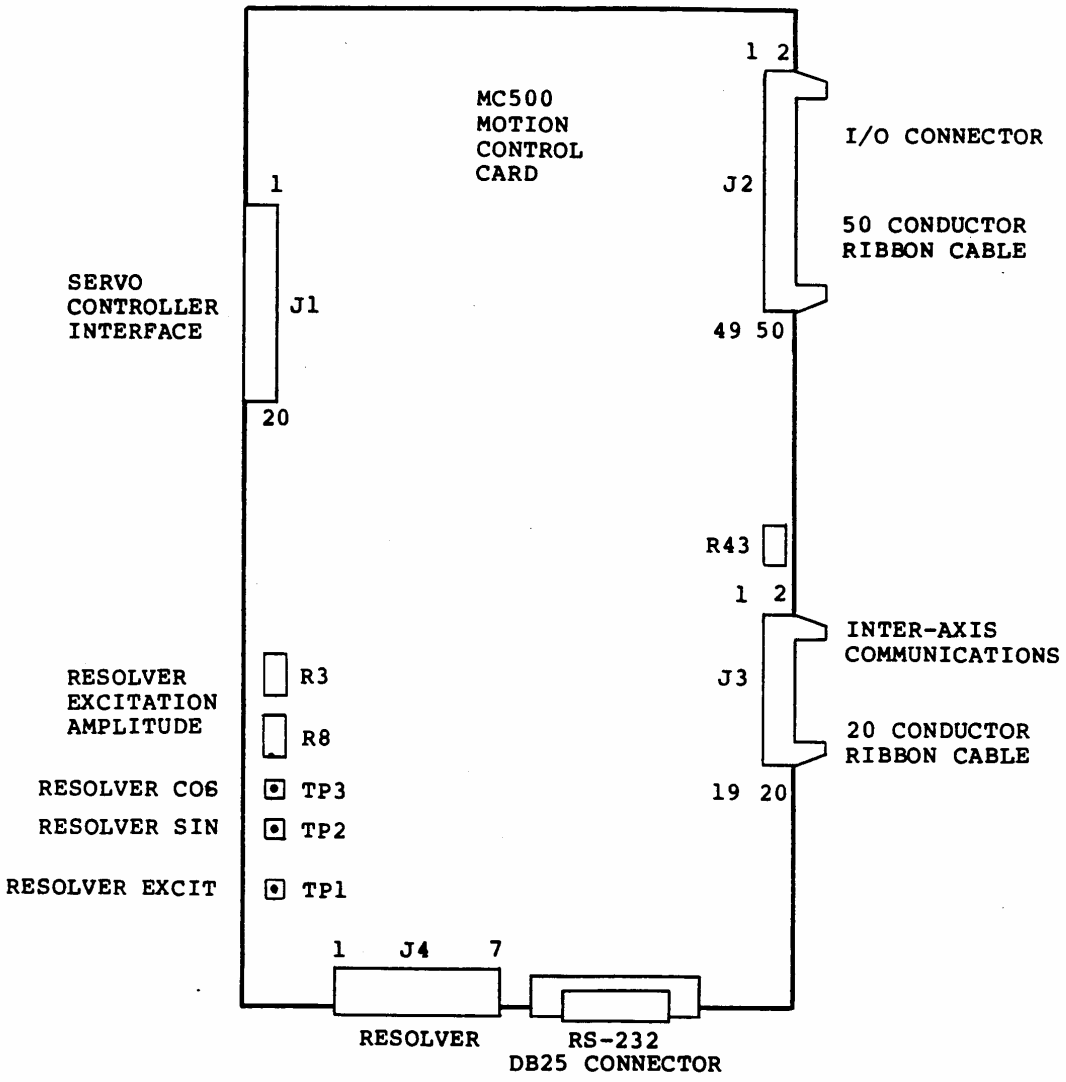
SBCTION 2

SPECIFICATIONS

2.1 General

Position Control	
Type:	Trapezoidal Profile
Resolution:	~0.00025 revolution
Accuracy:	
Electronics	~0.001 revolution
Resolver	~0.001 revolution
Speed Control	
Range:	o to ~10,000 RPM
Resolution:	5 RPM
Acceleration/Deceleration Control	
Range:	9100 to 150,000 RPM/S 910
Resolution:	RPM/S
Discrete Inputs	
Quantity:	8
Function:	Software configurable
Ratings:	+12 VDC, 2 mA sink, 50 uA source
Scan Rate:	1.024 mS
Discrete Outputs	
Quantity:	8
Function:	Software configurable
Ratings:	Open-collector, +15 VDC, 50 mA sink
Scan Rate:	1.024 mS
Serial Interface	
Type:	
Baud Rate: Parity: Data Word:	

RS-232 or RS-485
Half Duplex(does not echo) 1200
none
10 bit (8 data, 1 stop,
1 start)



MC500 MECHANICAL OUTLINE

FIGURE 2.1

SECTION 3

PROGRAMMING

3.1 General

This version of the MC500 Motion Control Card is intended for use in simple indexing applications. Up to 8 individual move profiles can be defined and stored for immediate selection by the 3 PROFILE SELECT inputs.

All moves are incremental and follow a trapezoidal velocity profile. Acceleration rate, deceleration rate, and run speed of the profile are user programmable. Several other parameters associated with the velocity profile are also programmable.

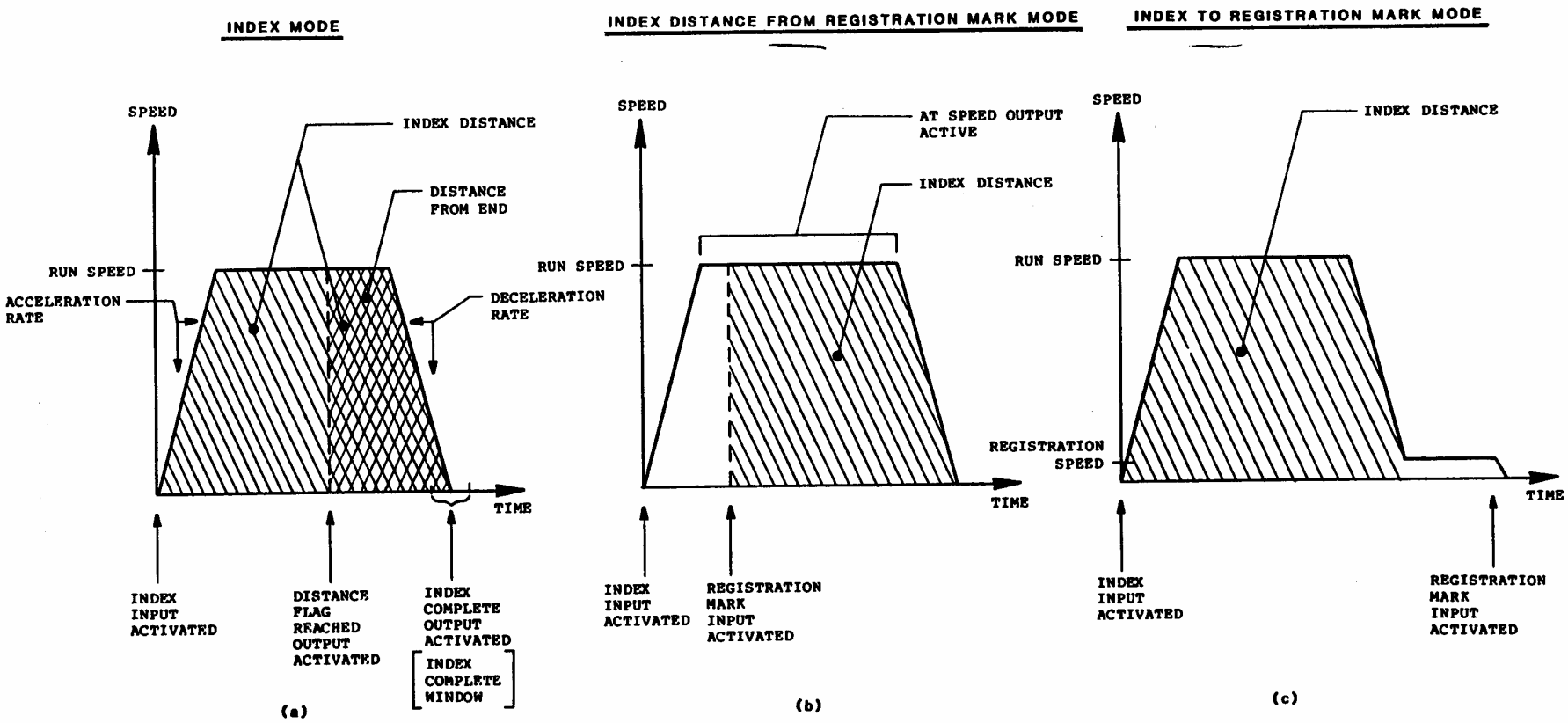
Programmable parameters are divided into two categories: OEM Parameters and User Parameters. OEM Parameters are only accessible via a lock code. These parameters are machine or system level parameters which would normally be set by the machine builder or by the user's engineering department. The User parameters define the actual velocity profiles and are accessible without a lock code.

Figure 3.1 shows the three index modes available in the Indexing Version of the MC500. The first mode, shown in Figure 3.1a, is the Index Mode. ~n this mode, the load is moved the programmed Index Distance through a trapezoidal velocity profile. The Registration Mark input is not recognized.

Figure 3.1b shows the Index Distance From Registration Mark Mode. In this mode, the load is accelerated to the programmed Run Speed at the programmed Acceleration Rate. Movement continues at Run Speed until the Registration Mark input goes active. Upon receiving an active Registration Mark input, the load will be moved the programmed Index Distance beyond the position at which the Registration Mark input was received. The move is completed using the programmed Run Speed and Deceleration Rate.

The third mode is shown in Figure 3.1c. In the Index To Registration Mark Mode, the load is moved the programmed Index Distance upon receiving an Index input. When it reaches the programmed Index Distance, motion continues at the Registration Speed rather than stopping as would occur in Index Mode. The load continues to move at the Registration Speed until the Registration Mark input goes active. Upon receiving an active Registration Mark input, the load is immediately decelerated to a stop at the programmed OEM Deceleration Limit rate.

The remainder of this Section describes the OEM and User parameters that can be programmed. It also describes the programming protocol or "language".



INDEX MODES

FIGURE 3.1

3.2 Programmable Parameter

Definitions

The programmable parameters are all stored in non-volatile memory and are entered or changed via the RS-232 serial port. The parameters are split into two classes: OEM parameters and User parameters. The OEM a parameters are only accessible via a code (lock co e - 4800) d control the system or machine level parameters. T e ser parameters control the actual move profile and do not require a lock code to access.

Each parameter has a 3 or 4 character abbreviation of its name. This abbreviation is used in programming the The parameters abbreviation is shown in brackets following its full name. Table 3.1 summarizes the parameter names and abbreviations.

Figure 3.1 illustrates the different Index Modes and also graphically shows what many of the OEM and User parameters control.

3.2.1 OEM Parameters

1. JOG SPEED HI (JOGH]
   Sets the motor speed for jogging when the JOG HI/LO input is in the HI state. Range of speeds is 100 rpm to 2500 rpm in 5 rpm increments. There is a check to make sure this speed is greater than JOG SPEED LO.

2. JOG SPEED LO (JOGL]
   Sets the motor speed for jogging when the JOG HI/LO input is in the LO state. Range of speeds is 5 rpm to 1000 rpm in 5 rpm increments. There is a check to make sure this speed is less than JOG SPEED HI.

3. POSITION LOOP GAIN (PGAI]
   The position error is multiplied by this gain to produce a velocity command which is summed with the velocity feed forward command. The resulting summation is the velocity command output. Range of gains is 0.4 V/rev to 50 V/rev in 0.4 V/rev increments.

4. VELOCITY FEEDFORWARD GAIN (VFF]
   The velocity profile command is multiplied by this gain and the result summed with the velocity command produced by the scaled position error. The resulting summation is the velocity command output. Range of gains is 0.01 V/rpm to 0 V/rpm in

0.0001 V/rpm
increments. This parameter can be adjusted to reduce the following error of the system.

5. INDEX MODE (IMOD]
Sets the mode of operation per the following table.

O = Index Mode
1 = Index Distance From Registration Mark Mode 2
= Index To Registration Mark Mode

6. ENGINEERING UNITS [ENGU]
This number is used to put all distances, speeds, and accelerations in the desired engineering units. The default value is 1 which keeps all parameters in revolutions, rpm, and rpm/s. The number entered here
~PlY:

Desired Units/1 motor shaft revolution

EXAMPLE: The motor is coupled to a 0.5" leads crew via a 2:1 gear reduction and you want to program in inches. For 1 motor shaft revolution, there is 0.25" of travel, therefore you should program 0.25 for engineering units. Distance will now be in inches, speeds will be in inch/min., and accelerations will be in inch/min/sec.

7. PTORQUE [PTQ] *J*
This is the [maximum positive torque (current) allowed~ It sets the amplifier current clamp at 10% to 100% of rated peak in 1% increments. This programmable current clamp is not supported by the SC400 servo controller.

8. NTORQUE [NTQ]
This is the maximum negative torque (current) allowed It sets the amplifier current clamp at 0 of rated peak in 1% increments. This programmable current clamp is not supported by the SC400 servo controller.

9. ACCELERATION LIMIT [ALMT]
This parameter defines the maximum or 100% acceleration level. The User parameter, ACCELERATION RATE, is a percentage of this level. The range is 9100 rpm/s to 150,000 rpm/s in 9100 rpm/s increments.

10. DECELERATION LIMIT [DLMT]
This parameter defines the maximum or 100% deceleration level. The User parameter, DECELERATION RATE, is a percentage of this level. The range is 9100 rpm/s to 150,000 rpm/s in 9100 rpm/s increments.

11. EQUAL ACCELERATION/DECELERATION [EQU]
This parameter allows the DECELERATION LIMIT/DECELERATION RATE to default to the same value as the ACCELERATION LIMIT/ACCELERATION RATE or be set independently. The mode is set per below.

O = DECELERATION = ACCELERATION
1 = INDEPENDENTLY SET DECELERATION

TABLE 3.1

Programmable Parameters Summary

Parameter	Abbreviation	Ranae
OEM Parameters		
JOG SPEED HI	JOGH	100 rpm - 2500 rpm
JOG SPEED LO	JOGL	5 rpm - 1000 rpm
POSITION LOOP GAIN	PGAI	0.4V/rev -*50V/rev*
VEL FEEDFORWARD GAIN	VFF	OV/rpm - O.OlV/rpm
INDEX MODE	IMOD	0 = index 1 = index from reg. 2 = index to req.
ENGINEERING UNITS	ENGU	?
PTORQUE	PTQ	10% - 100%
NTORQUE	NTQ	10% - 100%
ACCELERATION LIMIT	ALMT	9100rpm/s - 150,000rpm/s
DECELERATION LIMIT	DLMT	9100rpm/s - 150,000rpm/s
EQUAL ACCEL/DECEL	EQU	0 = equal 1 = independent
BASESPEED	BASE	500 rpm - 10,000 rpm
ADVANCE RATE	RATE	*Oo/rpm - 0.250/rpm*
User Parameters		
INDEX DISTANCE n	INDn	~ 100 revolutions
ACCELERATION RATEn	ACCn	10% - 100%
DECELERATION RATE n	DECn	10% - 100%
RUN SPEED n	SPDn	5 rpm - 10,000 rpm
REGISTRATION SPEED n	REGn	5 rpm - 500 rpm
INDEX COMPLETE WINDOW n	ICWn	0.001 rev - 0.1 rev
FOLLOWING ERROR WINDOW n	FEWn	0.1 rev - 10 rev
DISTANCE FROM END n	ENDn	0 rev - 100 rev

The system is now ready to run with the new Index #1 Distance value of -100.000 revolutions. Note that the index direction has been reversed by entering a "-" with the distance value.

OEM MODE

This mode allows the interrogation and/or modification of OEM Parameters and User parameters. This mode requires the entry of an unlock code, 4800~ before the mode can be activated. A parameter is interrogated and/or modified by entering the parameter abbreviation followed by an ENT. If the displayed parameter is to be changed, type a C followed b an ENT. The display will show the a reV1a 10n 0 owed by an equal sign and a blank field or the value. Type 1n the new value followed by an ENT. The new value will be held in the display. Type an ENT to return the display to the 0: state where a new abbreviation or mode change
can be accepted. If the original displayed parameter is okay, simply type an ENT which will return the display to its 0: state. An example of changing a parameter is given below.

~"J
~

Change the Acceleration Limit: .

Enter: ~ENT	
Display Responds:	[O:LOCK =]
Enter:	4 8 0 0 ENT
Display Responds:	[0:]
Enter:	A L M TENT
Display Responds:	[O:ALMT = 123456]
Enter: CENT	
Display Responds:	[ ]
Enter:	1 5 0 0 0 0 ENT
Display Responds:	[O:ALMT = 150000]
Enter: ENT	
Display Responds:	[0:]
Enter: RENT	
Display Responds:	[R:]

The system is now ready to run with the new Acceleration Limit value of 150,000 rpm/s. If the Lock Code is incorrectly entered, the MC500 automatically returns to the Run Mode. Note that in this mode parameters can be "changed on the fly". This is not possible in any other modes. Parameter changes made on the fly will become effective as soon as possible. The actual response time will depend upon the parameter changed and the system status at the time of the change.

~If this parameter is set to O, the programmed value for DECELERATION LIMIT and DECELERATION RATE will be ignored and the programmed values for ACCELERATION LIMIT and ACCELERATION RATE will be used.

12. BASESPEED [BASE]
This parameter is used to define the speed at which the phase advance will begin. The parameter has a range of 500 rpm to 10,000 rpm in 100 rpm increments. This parameter is dependent upon the motor winding and the servo controller bus voltage. Contact the factory for value to be used. If phase advance is not being used, set the parameter to 10,000 rpm.

13. ADVANCE RATE [RATE]
This parameter defines the rate at which phase advance will be applied. The parameter has a range of .250/rpm to O/rpm in .004/rpm increments. As with BASESPEED, contact the factory for the value to be used. Set this parameter to 0 if phase advance is not being used.

3.2.2 USER PARAMETERS

Up to 8 individual move profiles can be stored in the non-volatilememory. The desired move profile is then selected using the 3 PROFILE SELECT inputs. Each of these 8 profiles has 8 parameters associated- with it. These parameters are described below. The "n" at the end of each parameter name and abbreviation is replaced by the profile number (1 through 8) it is to be associated with.

1. INDEX DISTANCE n [INDn]
This is the desired index distance for index number n. The index number n corresponds to the 3 bit word on the PROFILE SELECT inputs and ranges from 1 to 8. Hence 8 different index distances can be stored and then the desired index selected via the PROFILE SELECT inputs. The range of distances is *t100* revolutions in 0.001 revolution increments.

2. ACCELERATION RATE n [ACCn]
This parameter specifies the acceleration rate used during profile n. The range is 10% to 100% in 10% increments. The 100% value is specified by the OEM parameter ACCELERATION LIMIT.

3. DECELERATION RATE n [DECn]
This parameter specifies the deceleration rate used during profile n. The range is 10% to 100% in 10% increments. The 100% value is specified by the OEM parameter DECELERATION LIMIT.

4. RUN SPEED n [SPDn]

This is the maximum speed attained during profile n. The range is 5 rpm to 10,000 rpm in 5 rpm increments.

5. REGISTRATION SPEED n (REGn]
For profile n, sets the speed at. which the system will search for the REGISTRATION MARK input when the system is in the Index To Registration Mark Mode. Range of speeds is 5 rpm to 500 rpm in 5 rpm increments.

6. INDEX COMPLETE WINDOW n (ICWn]
Sets the error window size inside which an active INDEX COMPLETE output will be given at the end of profile n. The value programmed is t around the final position. Range of the window size is 0.001 revolution to 0.1 revolution in 0.001 revolution increments.

7. FOLLOWING ERROR WINDOW n [FEWn]
For profile n, this is the maximum distance error allowed between the commanded position and actual position during the move without activating the FOLLOWING ERROR output. The value programmed is t.
Range of the window size is 0.1 revolution to 10 revolutions in 0.1 revolution increments.

8. DISTANCE FROM END n (ENDn]
This parameter specifies the distance from the end of a move at which point the DISTANCE FLAG REACHED output will be activated for profile n. The range of distances is tlOO revolutions in 0.001 revolution increments. This distance cannot be larger than its
respective INDEX DISTANCE and must be of the same sign. There is a check mechanism to insure this is true.

3.3 Programming Protocol

This section describes the programming protocol or "language" used in setting up the MC500. Programming is done
using any ASCII terminal having an RS-232 or RS-485 serial port. A host computer can also be used to program the MC500.

there are four modes of operation in the MC500: Run Mode,

User Mode, OEM Mode, and Test Mode. These modes are signified as To on the terminal display:

Run Mode	[R:]
User Mode	(U:]
OEM Mode	[0:]
Test Mode	(T:]

The system defaults to the Run Mode upon power-up. Modes can be changed by enter1nq the appropr1ate R, U, 0, or T key followed by an ENT (enter or carriage return). Mode changes will only be l~~vyul~ed aI~er all 1n-proqress commands have been

completed and motor motion has ceased. When the system is in the User Mode, all discrete I/O is inactive. In the Test Mode, only the I/O appropriate to the specific test being executed is active.

3.3.1 Run Mode

In this mode, User Parameters can be interrogated but not altered. To monitor a parameter, enter the appropriate parameter abbreviation followed by an ENT. Table 3.1 has a list of parameter abbreviations. The system will respond by echoing the abbreviation followed by an equal sign and the parameter's value. An example is given below.

Interrogate the Index #1 Distance:

```
Enter:              I N D 1      ENT
Display Responds: [R:IND1 = 98.165]
```

This indicates that the Index #1 Distance has been programmed to 98.1655 revolutions.

3.3.2 User Mode

This mode allows the interrogation and modification of User Parameters. A parameter is interrogated and/or modified by entering the parameter abbreviation followed by an ENT. If the displayed parameter is to be changed, type a C followed by an ENT. The display will show the abbreviation followed by an equal sign and a blank field for the value. Type in the new value
followed by an ENT. The new value will be held in the display. Type an ENT to return the display to the U: state where a new abbreviation or mode change can be accepted. If the original displayed parameter is okay, simply type an ENT which will return
the display to its U: state. An example of changing a parameter is given below.

Change the Index #1 Distance:

```
Enter:                U       ENT
Display Responds:     [U:             ]
Enter:                I N D     1  ENT
Display Responds:     [U:IND1 = 98.165]
Enter: CENT
Display Responds:     [               ]
Enter:                - 1     00 . 0  0  0ENT
Display Responds:     [U:IND1 =-100.000]
Enter: ENT
Display Responds:     [U:             ]
Enter: RENT
Display Responds:     [R:             ]
```

SECTION 4

INSTALLATION/SET-UP

Due to the wide variety of uses for this card and its host controller, it is the responsibility of the user or those applying the product to determine its suitability for any intended application. In no event will IMEC Corporation be responsible or liable for indirect or consequential damages resultinq from the use of this card.

The figures, tables and examples shown in this manual are intended solely to supplement the text. Because of the varied requirements of any particular application, IMEC Corporation cannot assume responsibility or liability for actual usebased upon the illustrative uses and applications included in this manual.

WARNING

DANGEROUS VOLTAGES, CURRENTS, TEMPERATURES, TORQUES, FORCES, AND
ENERGY LEVELS EXIST IN THE CONTROLLER AND MOTOR USED WITH THE MOTION CONTROL CARD. EXTREME CAUTION AND CARE SHOULD BE EXERCISED IN THE APPLICATION OF THIS EQUIPMENT. ONLY QUALIFIED INDIVIDUALS SHOULD WORK ON THIS EQUIPMENT AND ITS APPLICATION.

4.1 General

The MC500 Motion Control Card is factory installed in the host servo controller being used. Upon receiving the servo controller with an MC500 installed, inspect the Motion Control Card and servo controller for any physical damage that may have been sustained during shipment. All claims for damage whether concealed or obvious must be made to the shipper by the buyer as soon as possible after receipt of the unit.

Remove all packing materials from the unit. If the unit is to be stored, it should be stored in a clean, dry place. The
storage temperature should be between -550C and 70oC. To prevent damage during storage, it is recommended that the unit be stored in its original shipping carton after completing inspection for damage.

Refer to the servo controller's Instruction Manual for directions on mounting the host servo controller.

4.2 1/0 Definitions

The MC500 I/O has standard hardware names. These names are summarized in Table 4.1 Each version of the Application

Specific
Software for the MC500 assigns functional names to the hardware. These functional names are also shown in Table 4.1 for the Indexing Version Software [option code -??J.

Figure 4.1 shows the electronic hardware interface for each of the I/O pins.

The pin number, functional name, hardware name [J, and functional description for each I/O are given below. In some cases, the functional name and hardware name are identical and hence only one name is shown.

Connector J2

I/O POWER

J2-1,49 [I/O +5 VDCJ
These pins provide +5 VDC power for use in interfacing to the Discrete I/O. Maximum allowable load is TBD mA.

J2-11 [I/O +12 VDCJ
This pin provides +12 VDC power for use in interfacing to the Discrete I/O. Maximum allowable load is TBD mA.

J2-All [I/O RtnJ
Even All the even pin numbers on J2 are return pins for use Pins in interfacing the Discrete I/O.

DISCRETE INPUTS

J2-47 [ENABLEJ
The host servo controller is enabled when this input is held low.

J2-45 INDEX [DIOJ
The selected move profile is initiated by a falling edge on this input. This input is not recognized during a move or if the system has an active JOG CW or JOG CCW command. The response delay to this input is 1 mS maximum.

J2-43 HOLD/CONT [DI1]
In the HOLD state, which is active low, any move in progress will be interrupted. The velocity will be slewed to zero at the programmed deceleration rate for the move. The position at which the system stops will be held in a closed position loop. When the input is returned to the CONT or high state, the move will be coompleted. There will be a delay of up to 500 mS when a CONT command is issued before motion starts. The acceleration and deceleration rates programmed for the move will be observed in finishing the move. The move will be cancelled if any other discrete input is

~If this parameter is set to O, the programmed values for DECELERATION LIMIT and DECELERATION RATE will be ignored and the programmed values for ACCELERATION LIMIT and ACCELERATION RATE will be used.

12. BASESPEED [BASE)
    This parameter is used to define the speed at which the phase advance will begin. The parameter has a range of 500 rpm to 10,000 rpm in 100 rpm increments. This parameter is dependent upon the motor winding and the servo controller bus voltage. Contact the factory for value to be used. If phase advance is not being used, set the parameter to 10,000 rpm.

13. ADVANCE RATE [RATE)
    This parameter defines the rate at which phase advance will be applied. The parameter has a range of .250/rpm to O /rpm in .004/rpm increments. As with BASESPEED, contact the factory for the value to be used. Set this parameter to 0 if phase advance is not being used.

3.2.2 USBR PARAMBTBRS

Up to 8 individual move profiles can be stored in the non-volatile memory. The desired move profile is then selected using the 3 PROFILE SELECT inputs. Each of these 8 profiles has 8 parameters .associated. with it. These parameters are described below. The "n" at the end of each parameter name and abbreviation is replaced by the profile number (1 through 8) it is to be associated with.

1. INDEX DISTANCE n [INDn]
   This is the desired index distance for index number n. The index number n corresponds to the 3 bit word on the PROFILE SELECT inputs and ranges from 1 to 8. Hence 8 different index distances can be stored and then the desired index selected via the PROFILE SELECT inputs. The range of distances is ~100 revolutions in 0.001 revolution increments.

2. ACCELERATION RATE n [ACCn]
   This parameter specifies the acceleration rate used during profile n. The range is 10% to 100% in 10% increments. The 100% value is specified by the OEM parameter ACCELERATION LIMIT.

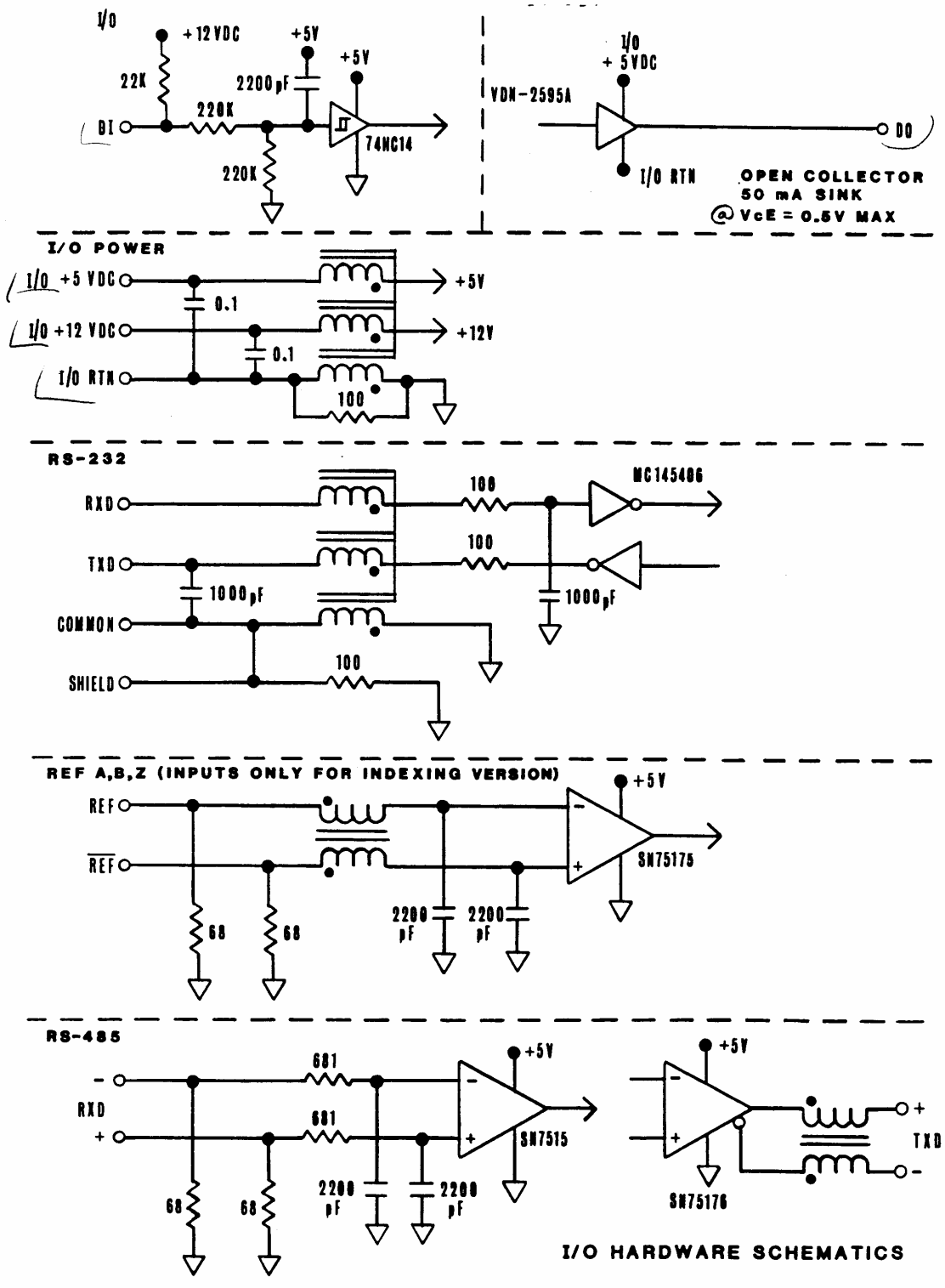
3. DECELERATION RATE n [DECn]
   This parameter specifies the deceleration rate used during profile n. The range is 10% to 100% in 10% increments. The 100% value is specified by the OEM parameter DECELERATION LIMIT.

4. RUN SPEED n [SPDn]

TABLE 3.1

Programmable Parameters Summary

Parameter	Abbreviation	Ranae
OEM Parameters		
JOG SPEED HI	JOGH	100 rpm - 2500 rprn
JOG SPEED LO	JOGL	5 rpm - 1000 rpm
POSITION LOOP GAIN	PGAI	0.4V/rev - 50V/rev
VEL FEEDFORWARD GAIN	VFF	OV/rpm - O.OlV/rpm
INDEX MODE	IMOD	0 = index 1 = index from reg. 2 = index to req.
ENGINEERING UNITS	ENGU	?
PTORQUE	PTQ	10% - 100%
NTORQUE	NTQ	10% - 100%
ACCELERATION LIMIT	ALMT	9100rpm/s - 150,000rpm/s
DECELERATION LIMIT	DLMT	9100rpm/s - 150,000rpm/s
EQUAL ACCEL/DECEL	EQU	0 = equal 1 = independent
BASESPEED	BASE	500 rpm - 10,000 rpm
ADVANCE RATE	RATE	Oo/rpm - 0.250/rpm
User Parameters		
INDEX DISTANCE n	INDn	~ 100 revolutions
ACCELERATION RATEn	ACCn	10% - 100%
DECELERATION RATE n	DECn	10% - 100%
RUN SPEED n	SPDn	5 rpm - 10,000 rpm
REGISTRATION SPEED n	REGn	5 rpm - 500 rpm
INDEX COMPLETE WINDOW n	ICWn	0.001 rev - 0.1 rev
FOLLOWING ERROR WINDOW n	FEWn	0.1 rev - 10 rev
DISTANCE FROM END n	ENDn	0 rev -100 rev



I/O HARDWARE SCHEMATICS

activated while the system is at zero velocity in the HOLD state. This input must be in the CONT state for an INDEX command to be recognized.

J2-41 JOG HI/LO [DI2]
This input selects which of two programmed speeds will be used when a JOG CW or JOG CCW command is given. This input can be toggled and recognized when a JOG CW or JOG CCW command is active. A high input corresponds to JOG HI and a low input corresponds to JOG LO.

J2-39 JOG CW [DI3]
This input will cause the motor to rotate clockwise at the selected programmed JOG HI or JOG LO speed as long as the input is held low. Acceleration and deceleration rates will be at the specified OEM acceleration/deceleration limits. This input will not be recognized if a move is in progress or if JOG CCW is active. It will be recognized during an active HOLD command but will cause cancellation of the interrupted move.

J2-21 JOG CCW [DI4]
This input will cause the motor to rotate counterclockwise at the selected programmed JOG HI or JOG LO speed as lonq as the input is held low. Acceleration and deceleration rates will be at the specified OEM acceleration/deceleration limits. This input will not be recognized if a move is in progress or if JOG CW is active. It will be recognized during an active HOLD command but will cause cancellation of the interrupted move.

J2-19 PROFILE SELECT 0 [DI5]
J2-17 PROFILE SELECT 1 [DI6]
J2-15 PROFILE SELECT 2 [DI7]
These three inputs form a 3 bit select word which select one of eight pre-programmed move profiles stored in memory. Each of these stored moves has its own acceleration rate, deceleration rate, run speed, and move distance parameters stored.

The three inputs are scanned when the INDEX input is activated, therefore any change in these inputs will only be recognized on the next INDEX command. The inputs are decoded as shown below.

J2-15	J2-17	J2-19	INDEX NUMBER
Low	Low	Low	1
Low	Low	High	2

Low	High	Low	3
Low	High	High	4
High	Low	Low	5
High	Low	High	6
High	High	Low	7
High	High	High	8

DISCRETE OUTPUTS

J2-37 FOLLOWING ERROR [DOO]
This output goes high if the actual position profile does not stay within the programmed following .error window band about the commanded position profile. This output is used to signal a machine jam or malfunction. The output "follows" the error copdition. The output is low when a move is not in progress.

J2-35 INDEX COMPLETE [DOl]
This output goes high when the index is completed within the position error band defined by the programmed index complete window. This output "follows" the error condition. The output is low during an active JOG command or a HOLD command. Response time is 1 mS maximum.

J2-33 AT SPEED [D02]
This output is high when the system is in the constant run speed portion of a move profile. It is low at all other times. Response time is 1 mS maximum.

J2-31 DISTANCE FLAG REACHED [D03]
This output goes high when the system reaches the programmed distance from the end of the move. This output is intended for use in triggering an external event at a desired point prior to completion of a move. The output goes low when the Index Complete output goes active. If a HOLD occurs, the output will hold its correct state through the HOLD. If the move is cancelled, the output will go to its low state. Response time is 1 mS maximum.

J2-29 PROCESSOR READY [D04]
This output is high when the microprocessor is powered and functioning properly.

J2-27 RUN MODE [D05]
This output is high when the card is in the Run Mode. It goes low in all other modes.

J2-25 SPARE [D06]
This output is not used in this software version.

J2-23 FAULT [D07]
This output goes high if there is a fault in the Motion

Control Card or the host servo controller.

NOTE: Pins J2-3,5,7,9,13 are not connected.

Connector J3

INTER-AXIS COMMUNICATIONS
J3-1,4, COMMON
7,10 These 4 pins are signal common.

J3-2 (REF A]
J3-3 (lREF A]
These two pins are a differential, bidirectional port and are not used by this software version.

J2-5 (REF B]
J2-6 [/REF B]
These two pins are a differential, bidirectional port and are not used by this software version.

J3-8 REGISTRATION HARK (REF Z]
J3-9 /REGISTRATION MARK (/REF Z]
This differential, bidirectional port is used as an input by this software version. The input is used as a reference point or stopping point for registration mode moves. There are three possible modes of indexing
operation; Index, Index Distance From Registration Mark, and Index To Registration Mark. The Index Mode simply indexes the programmed move distance and ignores the REGISTRATION MARK input.

The Index From Registration Mark Mode accelerates at the programmed acceleration rate to the programmed run speed upon receiving an INDEX command. It moves at run speed until it sees the REGISTRATION MARK input
transition from high tolow. It then moves the programmed index distance using the run speed and programmed deceleration rate.

The Index To Registration Mark Mode moves the programmed index distance using the programmed profile parameters upon receiving an INDEX command. When it reaches the programmed index distance, it runs at the programmed registration speed rather than stopping. It continues to run at the registration speed until the REGISTRATION MARK input goes from high to low at which time it immediately decelerates to zero at the specified OEM deceleration limit and holds.

A high input is defined as J2-8 high relative to J2-9.

If a single ended input is desired, a high is defined as J2-8 high relative to COMMON. Since the input is differential, a low to high transition REGISTRATION MARK signal can be used by applying the signal to J2-9 relative to COMMON.

In all modes, the REGISTRATION HARK input is not recognized except during a move. Response delay to this input is 20 uS maximum.

J3-11,14, 17 [COMMON)
These 3 pins are signal common.

J3-12 [+TXD 485)
J3-13 [-TXD 485)
This is the RS-485 serial port differential output.

J3-15 [+RXD 485)
J3-16 (-RXD 485)
This is t~e RS-485 serial port differential input.

NOTE: Pins J3-18,19,20 are not connected.

Connector J4

Resolver

J4 - 1 [RESOLVER Sl (+ SIN»)
J4 - 2 [RESOLVER S3 (- SIN»)
This differential input accepts the sine output from the Resolver feedback transducer. The signal amplitude from the Resolver should be 2 Vrms ~5%.

J4 - 3 [RESOLVER S2 (+ COS»)
J4 - 4 (RESOLVER S4 (- COS»)
This differential input accepts the cosine output from the Resolver feedback transducer. The signal amplitude from the Resolver should be 2 Vrms ~5%.

J4 - 5 [SHIELD)
This is the connection point for the shields for the Resolver cables.

J4 - 6 [RESOLVER R1 (+ EXCITATION»)
J4 - 7 [RESOLVER R2 (- EXCITATION»)
This output is the excitation signal for the Resolver feedbacktransducer. Its amplitude is adjustable by potentiometer R3.

Connector J5

RS-232

J5-l [SHLD)
This is the connection point for the RS-232 cable shield.

J5-2 [TXD 232)
This pin is the RS-232 serial port transmit point.

J5-3 [RXD 232)
This pin is the RS-232 serial port receive point.

J5-7 [COMMON)
This is the signal common for the RS-232 serial port.

NOTE: Pins J5-4,5,6 and J5-8 thru J5-25 are not connected.

4.3 Controller Wiring

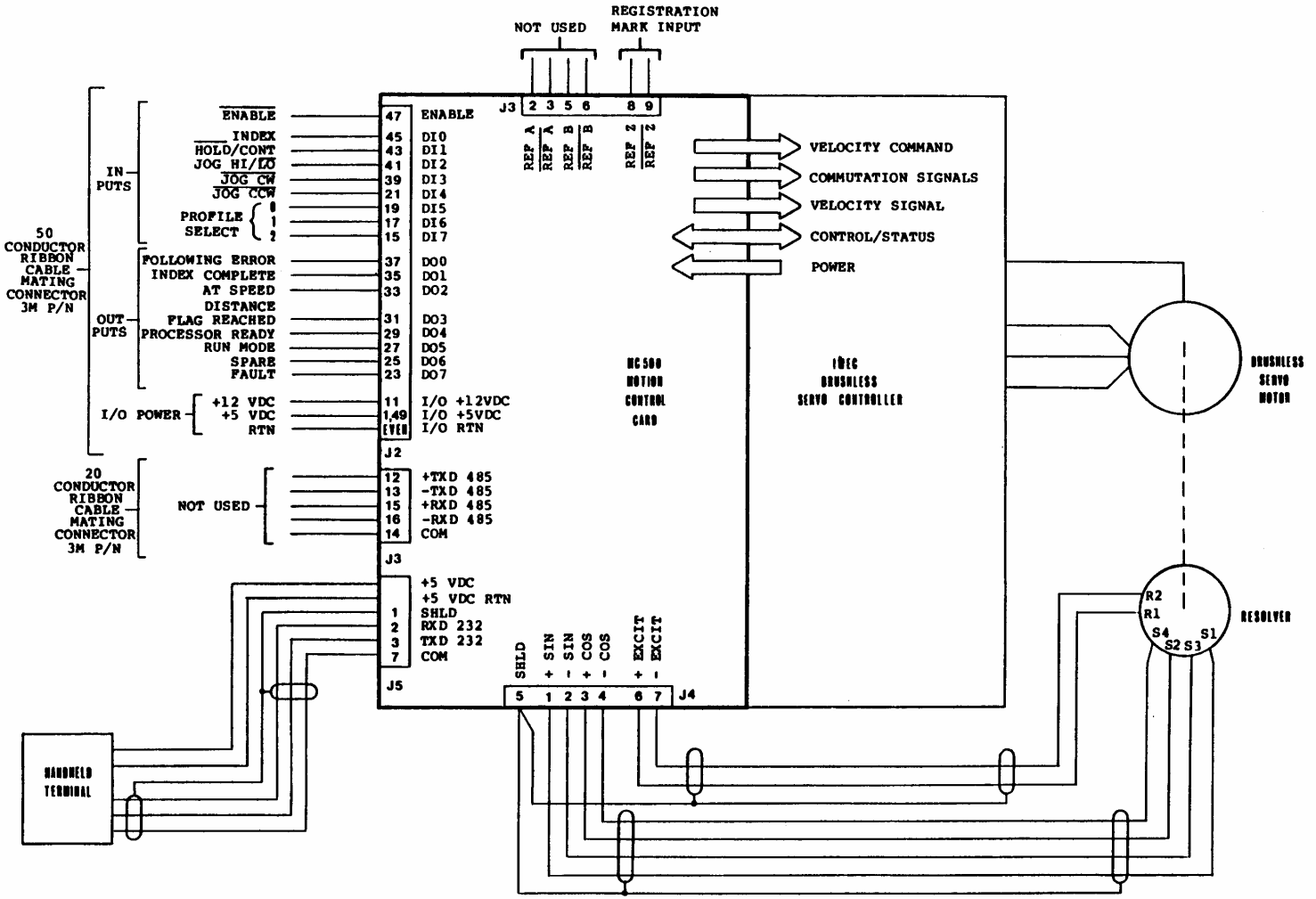
Figure 4.2 schematically illustrates the interconnection of the Motion Control Card.

Wire sizes, wiring practices, and grounding/shielding techniquesdescribed in this manual are intended as a guideline only. Due to the variety of applications served by the card/controller, no single method of interconnection is universally applicable. The information included in this manual represents common servo controller wiring practices and should prove satisfactory in the majority of applications. However, local electrical codes, special operating conditions or system configurations should take precedence over the information provided herein.

Due to the switching nature of the PWM servo controller used with the Motion Control Card, care should be exercised in routing power and signal wiring in the system. Noise radiated from nearby electrical or electronic equipment may cause undesired servo motor movement due to pickup by the MC500's signal inputs. Likewise, the servo controller's power outputs can generate noise which could be picked up by the MC500's signal inputs or by other electronic equipment where lines run near the servo controller's output wiring.

To reduce the possibility of noise pickup, power and signal lines should be twisted, shielded and routed separately wherever possible. Ideally the power and signal lines should be run in separate conduits or spaced at least 12" apart.

To minimize shock hazards to personnel and damage to equipment, all components of the servo system should have their chassis connected to a common earth ground point. Local electrical codes will usually outline the requirements regarding grounding of electronic equipment.



I/O WIRING

FIGURE 4.2

Refer to the servo controller's Instruction Manual for recommendations on wiring the servo controller.

4.4 Potentiometer Set-up

The Motion Control Card has one user adjustment located at the left side of the board, see Figure 2.1.

RESOLVER EXCITATION AMPLITUDE, R3

This single turn potentiometer is used to adjust the amplitude of the resolver excitation output voltage. After connecting the resolver to the MC500, monitor test point TP2 (see Figure 2.1) with an AC voltmeter. Turn the motor shaft until there is a maximum reading on the AC voltmeter. Leave the motor shaft positioned at the point which gives a maximum voltage reading. Adjust R3 to obtain a 2 Vrms +-5% reading on the voltmeter.

4.5 Initial Power Up

Every MC500 and its host servo controller is burned-in and fully tested before leaving the factory. However, it is possible that damage has been sustained by the controller during shipping. This Initial Power Up. procedure along with the servo controller's power up procedure should be followed to insure that the MC500 and controller have not sustained shipping damage and have been properly installed. If problems areencounteredduringthis procedure, refer to the servo controller's Instruction Manual or to the appropriate section of this manual.

The initial power up sequence makes us~ of the handheld terminal and the various MC500 built-in test modes. Read Section 3 and Section 5.1 prior to attempting the following power up procedure.

WARNING

It is recommended that this initial power up procedure be performed with the motor shaft disconnected from the load. Improper wiring or undiscovered shipping damage could result in undesired motor motion. If the motor is connected to the load during this procedure, be prepared to deactivate the ENABLE input if excessive motion occurs.

(1) Verify that the MC500 and servo controller have been wired and mounted per instructions is this manual and the controller's Hardware Instruction Manual.

(2) Insure that the ENABLE input is inactive (high).

rotation.

(15) Monitor the motor's speed using a handheld tachometer or some other means. Adjust the desired maximum system speed using the command gain adjustment on the servo controller. The motor should be rotating in a clockwise direction.

(16) Enter a 0 into the handheld terminal. The motor should step to zero speed.

(17) Enter a -1 into the handheld terminal. The motor should rotate nominally at the maximum system speed in a counterclockwise direction.

(18) Enter a 0 into the handheld terminal. The motor should step to zero speed.

(19) Deactivate (force high) the ENABLE input.

(20) Using the handheld terminal, return the MC500 to the Run Mode.

(21) The MC500 is shipped from the factory with default parameters and a sample profile stored for Index 1. See Table 4.2 for details on the default values and sample profile. The sample index profile can be run or new parameters and/or profiles can be programmed and run.

TABLE 4.1 MC500 Indexing Version I/O SIGNAL PIN-OUT

Pin Number	Hardware Name	Functional Sianal Name
I/O POWER		
J2 - 1,49	I/O +5 VDC	I/O +5 VDC
J2 - 11	I/O +12 VDC	I/O +12 VDC
J2 - EVEN PINS	I/O RTN	I/O RTN
DISCRETE INPUTS		
J2 - 47	ENABLE	ENABLE
J2 - 45	DIO	INDEX
J2 - 43	DI1	HOLD/CONT
J2 - 41	DI2	JOG HI/LO
J2 - 39	DI3	JOG CW
J2 - 21	DI4	JOG CCW
J2 - 19	DI5	PROFILE SELECT 0
J2 - 17	DI6	PROFILE SELECT 1
J2 - 15	DI7	PROFILE SELECT 2
DISCRETE OUTPUTS		
J2 - 37	DOO	FOLLOWING ERROR
J2 - 35	DOl	INDEX COMPLETE
J2 - 33	D02	AT SPEED
J2 - 31	D03	DISTANCE FLAG REACHED
J2 - 29	D04	PROCESSOR READY
J2 - 27	DOS	RUN MODE
J2 - 25	D06	SPARE
J2 - 23	D07	FAULT
INTER-AXIS COMMUNICATIONS		
J3 - 1,4,7,10	COMMON	COMMON
J3 - 2	REF A	REF A
J3 - 3	/REF A	/REF A
J3 - 5	REF B	REF B
J3 - 6	/REF B	/REF B
J3 - 8	REF Z	REGISTRATION MARK
J3 - 9	/REF Z	/REGISTRATION MARK
J3 - 11,14,17	COMMON	COMMON
J3 - 12	+TXD 485	+TXD 485
J3 - 13	-TXD 485	-TXD 485
J3 - 15	+RXD 485	+RXD 485
J3 - 16	-RXD 485	-RXD 485
J3 - 18,19,20	N/C	
RS-232		
J5 - 1	SHLD	SHLD
J5 - 2	TXD 232	TXD 232
J5 - 5	RXD 232	RXD 232
J5 - 7	COMMON	COMMON
J5 - ?	+5 VDC	HANDHELD TERM. POWER
J5 - ?	+5 VDC RTN	HANDHELD TERM. POWER RTN

TABLE 4.2

FACTORY DEFAULT PARAMETER
AND SAMPLE INDEX PROFILE

Parameter	Abbreviation	Default Value

SECTION 5

TROUBLESHOOTING

This section is divided into two parts. The first sub-section outlines the use of the built-in Test Modes. These Test Modes are useful in initial system set-up and also in diagnosing faults or problems in the system. The second sub-section covers general system troubleshooting.

5.1 Test Modes

This mode allows the selection and use of various built-in test features. To prevent unauthorized use of the Test Mode, this mode can only be accessed through the use of a fixed lock code which must be entered prior to test selection. This code is fixed as 4321.

The Test Mode is accessed by entering T followed by an ENT. Next, the lock code must be entered. After entering the lock code, the desired Test Mode number can be selected. The Test Modes are listed below. Each test has its own display and/or input format.

An example of using a Test Mode is given

below.

Test the Discrete Outputs:

Enter: T ENT		
Display Responds:	[T:LOCK =	]
Enter:	4 3 2 1	ENT
Display Responds:	[T:#	]
Enter:	3 ENT	
Display Responds:	[T:#3 c	]
Enter:	1 0 1 0 1 0 1 0	ENT
Display Responds:	[T:#3 = 10101010]	

Discrete outputs 7,5,3,1 will go high.

Enter: ENT		
Display Responds:	[T:#3 =	]
Enter: TENT		
Display Responds:	[T:#	]
Enter: RENT		
Display Responds:	(R:	]

1. TEST MODE 1 [Velocity Command DAC Test]
   This mode is used to test the velocity command output

DAC. Itis also useful for settingup the motor's maximum speed by using it in conjunction with the servo

controller's velocity command gain potentiometer. This test mode allows the DAC output to be commanded as follows:

O = 0 volt DAC output
+1 = Full scale positive DAC output (+9 V)
-1 = Full scale negative DAC output (-9 V)

2. TEST MODE 2 [Torque Limit DACs Test)
This mode is used to test the torque limit output DACs. The DACs can be commanded as follows:

O = zero output on positive and negative DAC (0 V)
+1 = Full scale output on positive DAC (+5 V)
-1 = Full scale output on negative DAC (+5 V)
2 = Full scale output on both DACs (+5 V)

Note that this test is not applicable to an SC450 system.

3. TEST MODE 3 [Discrete Output Test)
This mode is used to activate the discrete outputs. The 8 outputs are represented by an 8 bit binary word. Each bit controls its respective output i.e the MSB controls output D07 while the LSB controls output DOO.

DO OUTPUT #	7	6	5	4	3	2	1	0
BIT	X	X	X	X	X	X	X	X

Set: BIT = 1 for output high
BIT = 0 for output low

4. TEST MODE 4 (Discrete Input Test)
This mode is used to monitor the discrete inputs. The 8 inputs are represented by an 8 bit binary word. Each
bitindicates its respective input status i.e the MSB
indicates input DI7 while the LSB indicates input DIO.

DI INPUT #	7	6	5	4	3	2	1	0
BIT	X	X	X	X	X	X	X	X

Read: BIT = 1 for input high
BIT = 0 for input low

5. TEST MODE 5 [Resolver Interface Test)
This mode is used to verify the resolver and RDC operation. It simply displays the RDC's 12 bit binary output word. By rotating the resolver, its output can be monitored to verify proper operation of all components as well as proper wiring. Clockwise rotation of the motor will cause the binary word to increase while counterclockwise will cause the binary word to decrease.

6. TEST MODE 6 [Inter-axis Interface Test]
This mode is used to verify the operation of the inter-axis communication interface. It displays a 3

bit binary word representing the REF A, REF B, and REF Z lines of the interface. Note that these interface lines have bidirectional hardware capability but for this version of the MC500 they are set-up as inputs. Only the REF Z input is used by the software but all 3 inputs are monitored by this test mode. Hence, this mode will display a 3 bit binary word which represents the status of the 3 inputs. The MSB corresponds to the REF A input and the LSB corresponds to the REF Z input. A BIT = 1 indicates a high input while BIT = 0 indicates a low input.

7. TEST MODE 7 [Self-test Routine]
This is a self-diagnostic test routine which checks all memory on the MC500 as well as other internal hardware and software. The display will contain the message TESTING while this test is in progress. If the card is okay, a PASS message will appear on the display upon completion of the test. If the card is not okay, a Fault Code number will be displayed. The Fault Codes are summarized below. This self-diagnostic test takes less than 5 seconds.

Fault Code	Fault Description
01	RAM error
02	EPROM error
03	EEPROM error
04	Watchdog error

5.2 General Troubleshooting

A fault in the MC500 or the host servo controller will cause the Fault Output 1D07] to go high. If a fault is indicated, the first step is to determine if the fault is in the MC500 itself or the host servo controller. The host servo controller has its own fault LED(s) which along with the controller's Instruction Manual Troubleshooting Guide should allow the determination of whether the servo controller is the source of the fault. If the servo controller is the source of the fault, follow the controller's Instruction Manual directions for eliminating the fault.

If it is determined that the servo controller is not the source of the fault, troubleshooting should be performed on the MC500. The MC500 outputs a Processor Ready status signal on discrete output D04. This output, along with the Fault Output, should be monitored during troubleshooting.