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UNIDEX® 14
OPERATORS
MANUAL

PN: EDU 117

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CHAPTER 1: INTRODUCTION

SECTION 1-1: GENERAL DESCRIPTION

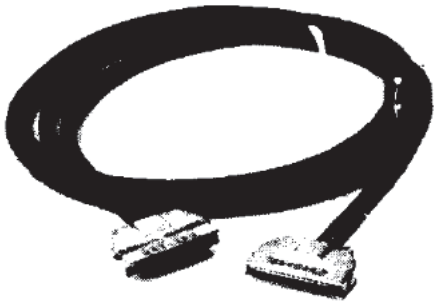
The Unidex 14 Motion Control system provides the PC/XT/AT, PS/2-30, and other compatible personal computer users the ability to integrate motion control onto the PC Bus. It consists of a PC-bus Indexer, a Drive chassis, PC to Drive Cabling and software support. It is fully compatible with Aerotech motors and positioning stages.

The Unidex 14 Indexer card occupies one full slot on the PC Bus and meets all IBM I/O standards. All programming languages with I/O capability such as Basic, C, and Pascal may be used to program the Unidex 14. Aerotech provides software support on disk with helpful utilities which may be incorporated into the users application programs.

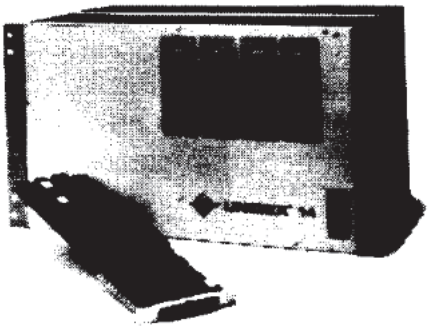
The Unidex 14 provides one to four axis point-to-point and linear interpolation as well as two axis circular interpolation. Motions may be programmed to be performed either absolute or incrementally. Auxiliary outputs can be turned off and on while contouring, making the Unidex 14 suited for many special applications. With sinusoidal acceleration and deceleration the Unidex 14 has virtually eliminated jerk during positioning.

The Unidex 14 Drive Chassis is available in two packages; a 6U - 12" high desktop cabinet - Model U14S and a 6U - 19" rack mount chassis - Model U14R. The PC-Bus card is available independently as Model U14C. These configurations are shown in Figure 1-1. Both configurations are capable of DC, AERODRIVE and Micro-Step drive control. Any combination of DC, AERODRIVE or Micro-Stepping drives may be accommodated.

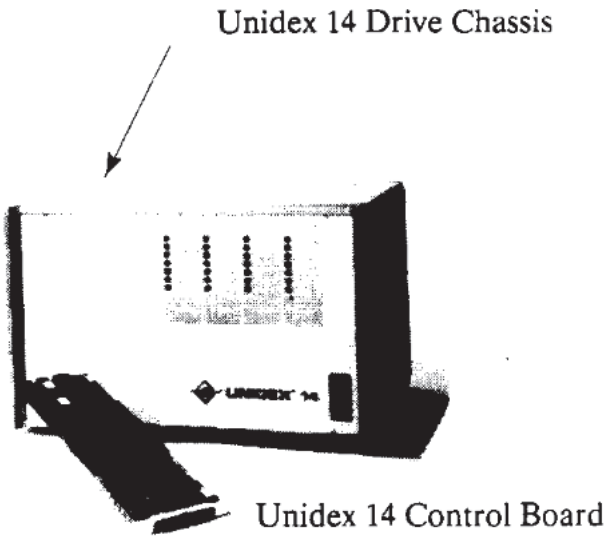
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Unidex 14 Control Board/ Drive Chassis Interconnect Cable



Unidex 14 Model U14R



Unidex 14 Model U14S

Figure 1-1:Unidex 14 Motion Controllers

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SECTION 1-2: SPECIFICATIONS

1-2-1: FUNCTIONAL SPECIFICATIONS

MEASURES	
Resolution	
Stepping Models	4,000 steps/rev. (0.09") standard; 400 to 50,000 steps/rev. (0.9" to 0.0072") optional
Servo & AERODRIVE Models	2,000 steps/rev. (0.18") standard; 200 to 4,000 steps/rev. (1.8" to 0.09") optional
Accuracy	
Stepping Models	+/-5 arc min. typical, unloaded, bidirectional
Servo & AERODRIVE Models	+/- 5 arc min. typical, loaded, bidirectional
Repeatability	+/- 5 arc sec. typical unloaded, unidirectional approach
Hysteresis	3 arc min. or less, unloaded, bidirectional (Stepping models only)
MOTIONS	
Axes	1 to 4 (designated X,Y,Z,T)
Type	Linear Interpolation and point-to-point (four of four axes); circular interpolation (any two axes); synchronous or multitasking; velocity profiling; velocity streaming; free-run
Position Range	8 1/2 digit position register
Stepping Models	+/- 16,750 rev. with standard resolution
Servo & AERODRIVE Models	+/- 33,500 rev. with standard resolution
Velocity Range	
Stepping & AERODRIVE Models	0.03 to 3000 rpm (0.0005 to 50 rev./sec.) with standard resolution
Servo Models	0.03 to 5000 rpm (0.0005 to 83 rev./sec. with standard resolution
Acceleration Ramp	0 to 8,000,000 pulses/sec./sec.
Acceleration Profiles	Linear, parabolic, or sinusoidal (programmable)
Positioning Modes	Absolute, incremental (programmable)
PROGRAMMING	
Memory(user)	200 character command buffer for each axis; 124 character input buffer
Loop/Wait commands	Loop specified number of times; loop until input LOW; loop until input commanded from host PC; wait until input HI; wait specified time
Scaling	Per axis multiplier permits scaling in metric, english or rotary units
Other Features	Output on-the-fly while contouring; encoder verification (stepping)
INTERFACES	
Command	PC/XT/AT interface, meets IBM I/O channel signal specifications and definitions; indexer card occupies one full I/O slot;

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	I/O address block is user selectable; Interrupt vector is user selectable for levels 2 through 7
Inputs/Outputs	
Dedicated	Buffered inputs per axis for cw, ccw, home limits, marker, amplified sine or line driver encoder
Programmable	5 inputs, optoisolated; 4 outputs, optoisolated; 4 auxil iary outputs, optoisolated (servo and AERODRIVE models only)
Serial Output	Optional serial output (SEO) makes available optoisolated clock, direction, and marker commands (stepping) or cw, ccw clock, and marker (servo and AERODRIVE) for external use.
Brake Control	Optional Output (Opto 22* OD5, rated for 60 VDC @2A) to control electromagnetic brake

CHASSIS WEIGHTS

U14C	Bus card only: 1 lbs. (0,5kg)
U14S	Stepping & AERODRIVE: 36 lbs. (16,5 kg); D-C Servo: 50 lbs. (23 kg)
U14R	Stepping & AERODRIVE: 30 lbs. (13,5 kg); D-C Servo: 42 lbs. (19 kg)
U14H	Stepping & AERODRIVE: 45 lbs. (20,4kg):D-C Servo: 57 lbs. (25,9kg)

ENVIORMENTAL

Ambient Temperature	
Operating	0° to 50° C (32° to 132°F)
Storage	-20° to 70° C (-4° to 158°F)
Humidity	0 to 95%, noncondensing

POWER INPUT

Driver Chassis	115 VAC, 50/60 Hz. (nom.), 1,000 VA (max.), single-phase Optional 230 VAC (nom.) or 100 VAC (NOM.), 50 Hz.
PC-Bus Indexer	+5 VDC @ 1.75 amps (nom.) from PC/XT/AT bus
Optoisolated I/O	+5 VDC @ 0.15 amps

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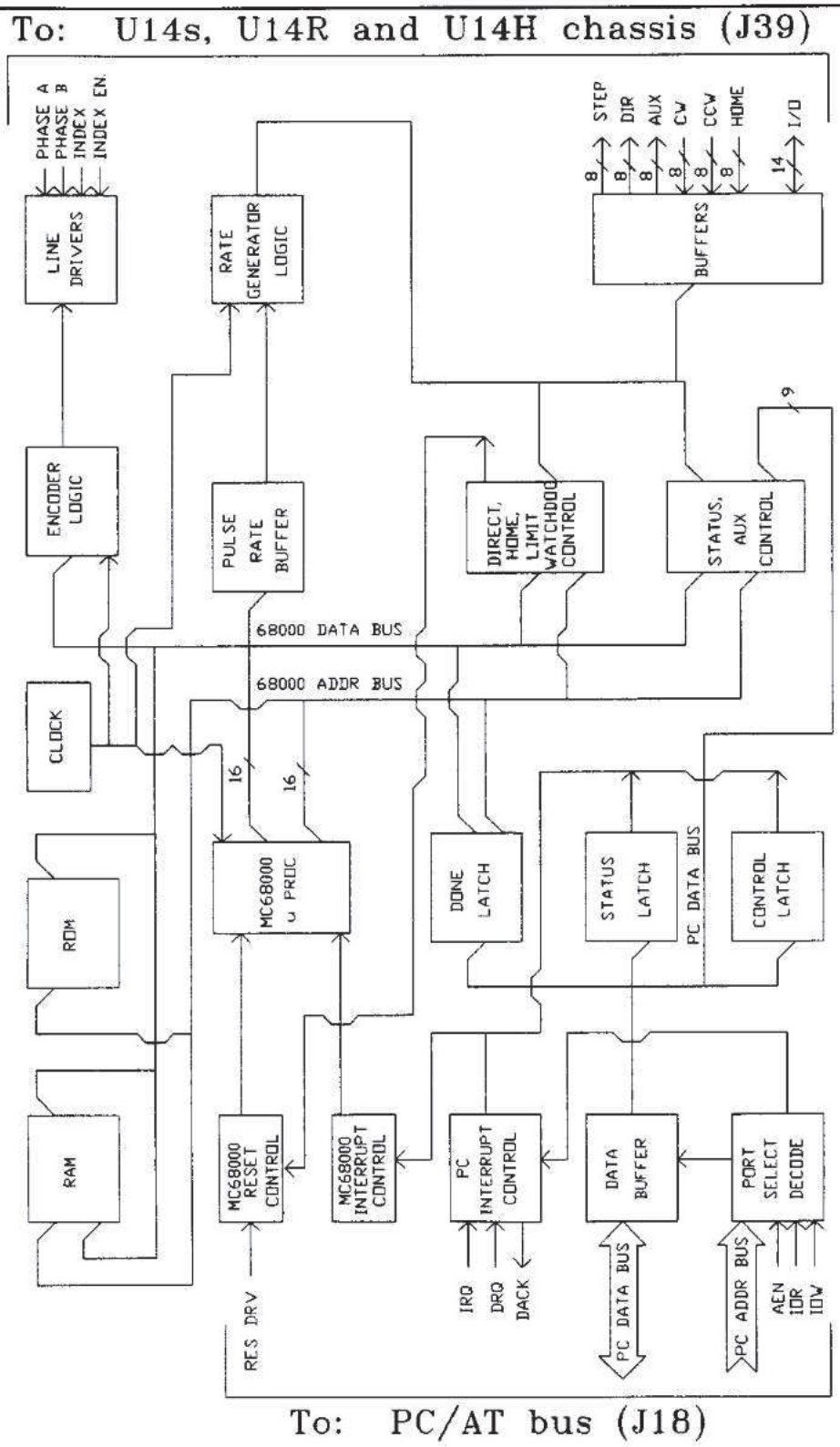


Figure 1-2:Unidex 14 Control Board Block Diagram

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CHAPTER 2: GETTING STARTED

SECTION 2-1: INTRODUCTION

The Unidex 14 Motion Controller can control as many as 4 axes of motion from one I/O slot of a PC/XT/AT or compatible computer. It meets the IBM I/O channel specifications and can be interfaced directly into the backplane of these machines. The Unidex 14 can for example simultaneously control four axes of open loop stepping motors while monitoring their actual position with the built in incremental encoder interface. The Unidex 14 can be set to correct the stepping motors to the desired position at the end of the indexers move. In addition "closed loop" DC Servo Motors and Aerodrive Servo Modules can be installed in the U14 driver chassis to provide closed loop brush or brushless motor control. A Unidex 14 can manage coordinated or independent motion on each of the four axes simultaneously.

The Unidex 14 functions as a motion coprocessor within the PC/XT/AT or compatible computer. It utilizes a 68000 microprocessor and patented proprietary technology to control direction of motion, acceleration, deceleration and velocity of an associated motor. In response to commands from the host computer, the Unidex 14 controller will calculate the optimum velocity profile to reach the desired destination in the minimum amount of time while conforming to the programmed velocity and acceleration parameters. A block diagram of the Unidex 14 Control Board is shown in Figure 1-2.

Commands may be sent to the Motion Controller by simple I/O commands using virtually any language on the PC which has the ability to do I/O. These controllers are easily programmed using ASCII character strings. For a typical motion requirement of 1,000,000 pulses at 400,000 pulses/sec and an acceleration of 500,000 pulses/sec/sec the following string would be sent from the host computer to the Unidex 14:

VL400000 AC500000 MR1000000 GO

For additional programming examples see Section 8.

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SECTION 2-2: THEORY OF OPERATION

The 68000 microprocessor of the Unidex 14 controller maintains four concurrent processes. The highest priority process calculates the desired pulse frequency 1024 times each second with a proprietary algorithm (patent number 4,734,847). This number is fed to U62, U63, U64 and U65 which synchronizes the motor pulses to the microprocessor and actually generate the pulse train. The velocity profile and synchronization of each axis is also handled by the 68000. (See Section 2-5 for more information).

The commands from the PC/XT/AT or compatible host computer are temporarily stored in a 124 character buffer until the 68000 microprocessor can parse them. The command is then executed immediately or routed to separate command queues for each axis. The command queue contains a list of addresses to execute followed by an optional parameter. A command from the host may be expanded into several commands to the appropriate axis. The GO command for example will expand into start, ramp up, constant velocity and ramp down commands. The LS command will save its parameter, i.e. the loop count, on a loop stack along with the address of the LS command to used by the next LE command as a target for a jump command. The LE command will decrement the loop count and jump to the most recent LS command providing the loop count has not reached zero. If the loop count has reached zero and it is not nested inside another loop, the queue space will be flagged as available and the next instruction in the queue will be executed.

Interrupts to the PC/XT/AT host are latched by U33. (Refer to Figures 5-2 through 5-21 Circuit Schematics of the U14C Control Board.) The enable status of each interrupt is also stored by U33. Status of the interrupts and error flags may be read by the host via U33. U12 latches the interrupt request enable bits and allows them to be read back by the microprocessor. U16 compares the Unidex 14 address to the I/O address selected by the host and enables the board decode logic when a match is detected.

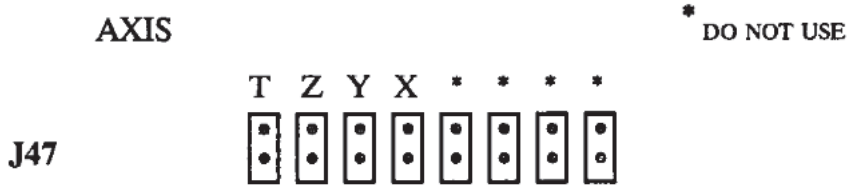
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SECTION 2-3: U14C

2-3-1: U14C JUMPER CONFIGURATIONS

The U14C board requires one full length slot in the PC/XT/AT. **In most cases the jumpers on the U14C board will not have to be changed if there are no conflicts with interrupt and I/O address lines.** The factory default settings for the board provide for I/O addresses 300 to 303 (hex) and the IRQ5 interrupt line. If these do not conflict with any previously installed hardware in your computer then you will not need to change any jumpers on the U14C board. There are seven blocks of square pin jumpers on the U14C board J47, J15, J17, J67, J57, J19 and JP79. See Figure 2-1 for the location of the jumpers.

J47 determines whether the limit inputs to an individual axis are active low or active high. (Note: If limits polarities are to be changed, see also Chapter 6 Drive Modules.) With the jumper in place, the associated axis will stop moving if the limit line, for the direction the axis is moving, is grounded. With the jumper removed, the axis will stop if the limit line is at +5 volts. These lines are internally pulled-up with a 2.2K ohm resistor to +5 volts so that only a switch is required to control the limit lines.



Limit Sense Jumpers for Four Axes Board

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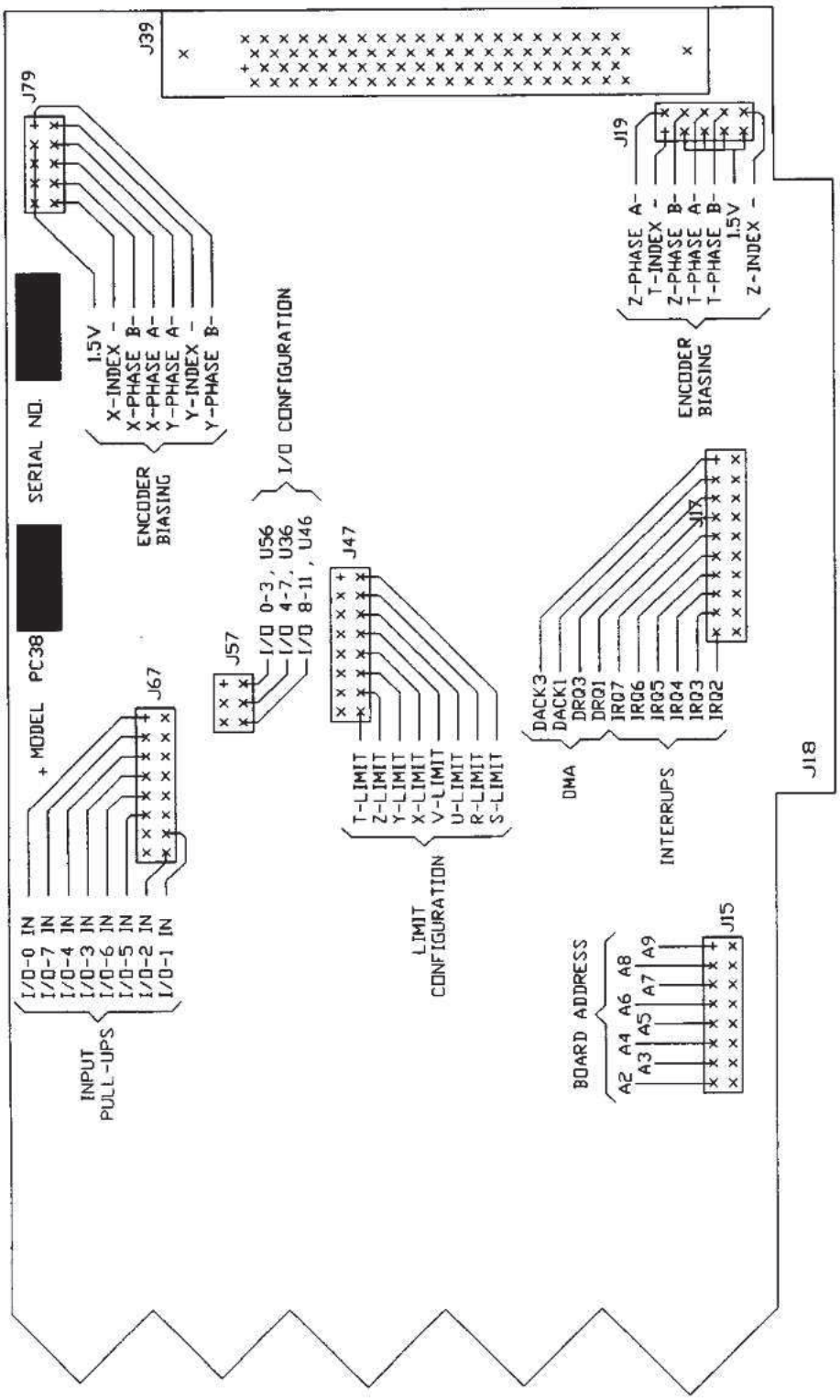
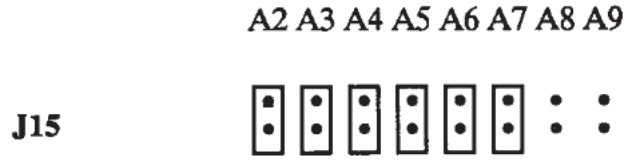


Figure 2-1: Location of Option Jumpers 6U U14 Control Board

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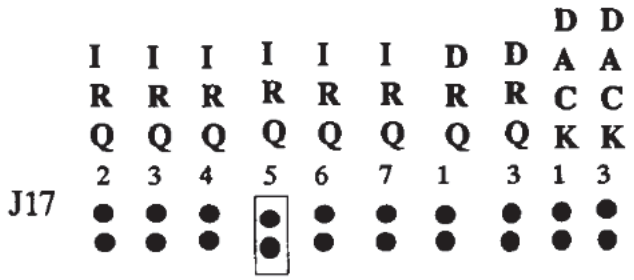
J15 determines the I/O address range of the board. A jumper across a pair of pins sets that bit in the address low. With the jumper removed the bit is high. The computer's I/O address ranges from 200 to 3FF (hex). The A0 and A1 address lines of the PC are decoded internally by the Unidex 14 board and are assumed to be 0 for base address calculations. The jumpers set the base address lines A2 through A9. The factory default address is 300 hex. This requires jumpers across A2 and A3, making all four of the lowest bits a 0 and the least significant hex digit of the address a 0. Jumpers across A4, A5, A6 and A7 make the middle four bits 0, making the middle hex digit of the address a 0. Removing the jumpers from A8 and A9 makes each of these lines a 1, making the most significant hexadecimal digit a 3.



Address Select Jumpers (Default Setting)

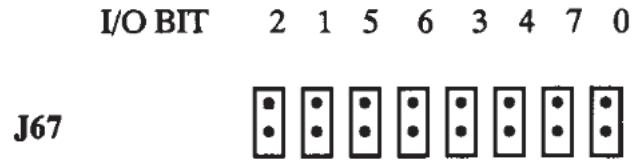
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J17 determines which interrupt level the U14C board will use when it communicates. IRQ5 is the factory default setting. This jumper block also controls which DMA control lines are used by the board, if DMA is used by the controlling program. The DMA lines are unused in most applications. The program U14_CDMA.C on the DEMO disk and listed in the software section uses DRQ1 and DACK1 lines. If that program is used, jumpers need to be placed across those sets of pins.



Interrupt and DMA Jumpers

J67 connects I/O bits 0-7 to pull-up resistors when they are configured as inputs. J57 is directly below J67 and selects the configuration of I/O bits 0-11 as inputs or outputs. A jumper on pins 3 and 4 of J57 selects I/O bits 0-3 as inputs. Note that U56 must be a 7402 when these pins are configured as inputs. No jumper on pins 2 and 5 of J57 selects I/O bits 8-11 as outputs and U36 must be a 7400 or 7438 open collector gate. Figure 2-2 shows the required configuration for an input bit while Figure 2-3 shows the configuration for an output bit. (See also Figure 5-21)



User I/O Pull-Up Jumpers (Default Setting)

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J79 and J19 are for biasing unused encoder inputs. When a single end encoder is used, the unused inputs can be biased using wire-wrap wire or jumpers. J79 is for the X and Y axes and J19 is for the Z and T axes. See Figure 2-1 for jumper locations.

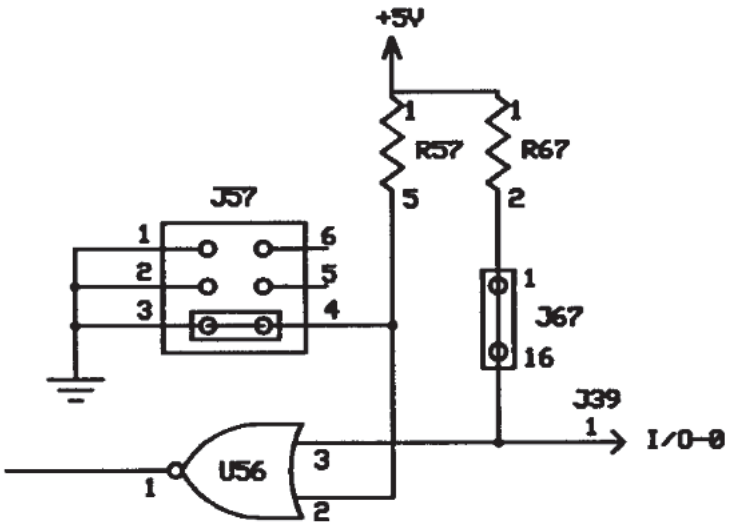


Figure 2-2: User I/O Input Configuration

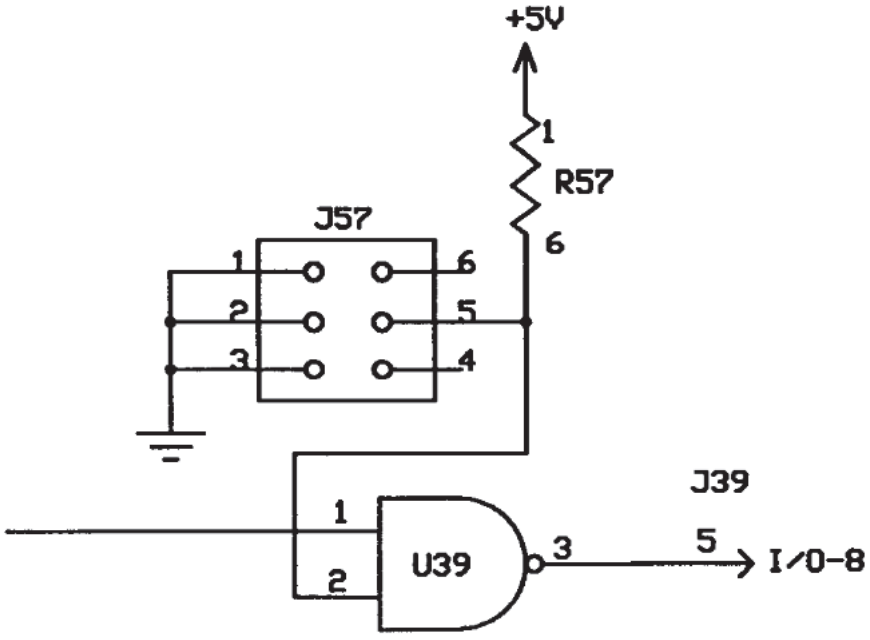


Figure 2-3: User I/O Output Configuration

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2-3-2: HARDWARE INSTALLATION FOR U14 CONTROL BOARD

1. Turn the computer power off and disconnect its power cord from power source.

   DANGER: PRIOR TO INSTALLING THE U14C. MAKE CERTAIN ALL POWER CONNECTIONS ARE DISCONNECTED.

2. Remove the computer's cover.

3. Choose an empty expansion slot in the mother board and remove its associated metal cover from the back of the computer. Be sure to save the screw.

4. Check the U14C board's jumpers for proper configuration.

5. Slide the U14C board down into the edge connector, insuring the board is lined up correctly in the card guides and firmly in the connector.

6. Use the screw removed from the cover to attach the metal bracket of the U14C board to the chassis of the computer.

7. Make certain that the board it is properly seated in the connector.

8. Replace the cover of the computer.

9. Replace the power cord and turn thecomputer on. (For ease of trouble-shooting do not connect U14C to other parts ofsystem until communication is established with thehost.)

10. Allow the computer to boot up.

11. When boot-up is complete, install the Support Disk into the floppy disk drive. If the factory default jumper settings are being used, type: A:U14_BAS. This loads the program, and allows the User to enter Unidex 14 control commands at the keyboard or to download a file of commands. The responses fromtheU14C board will be displayed on the computer's screen.

    Display the"README"file for information pertainingtothe most current Unidex 14 software.

NOTE: TheREADMEfile may contain software support information, not contained in this Manual, that is pertinent toUnidex 14 operation.

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12. To enter the terminal emulation mode without downloading a command file, press a Carriage Return when the program asks for a file name.

13. The program will state that you are in the interactive mode. Enter the Unidex 14 commands EN WY on the keyboard. EN turns echoing on which causes the typed commands to be echoed from the controller to the display. WY asks the U14C board "who are you". The board responds with its model type and firmware version number. (i.e. PC38 ver 1.39-4E)

14. If a similar message is displayed, the board was correctly installed and communication is established with the Unidex 14.

15. If no similar message is displayed, verify the installation procedure, if the problem cannot be determined, contact the Customer Service Department at AEROTECH, Inc. for assistance.

2-3-3: SOFTWARE INSTALLATION

The Support Disk contains several versions of a program which allow the User to interact with an AEROTECH U14C control board. The User may type Unidex 14 commands on the computer's keyboard and they are passed to the U14C board. The U14C board's responses are displayed on the computer's screen. The User may, when prompted, optionally give the program the name of an ASCII text file that contains Unidex 14 commands. The program will send the contents of the file to the U14C board.

All C language programs were compiled using either Microsoft Quick C or Microsoft C Version 5.0 Optimizing Compiler. Older versions of this compiler and C compilers from other companies may not compile this program properly because of it's use of hardware interrupts. The program U14_BAS.BAS was compiled using the Microsoft QuickBASIC Version 4.5 complier.

Most of the programs expect the U14C board to be jumpered to the factory default I/O address of 300 HEX. The "C" versions use IRQ5 to communicate with the U14C board. This is the factory default setting. The BASIC and Pascal versions do not use interrupts, instead they use polling.

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Also on this disk are the following: a program U14_CDMA.C that uses the PC/XT/AT DMA controller to send commands to the U14C board. If this program is executed, the appropriate jumpers on the U14C board will have to be configured.

The source code for these programs is included on the disk allowing Unidex 14 Users to use the routines in application programs. No license is required. The programs are also listed in the software section of this manual. Refer to the software Support Disk provided for the most current example programs (this manual may not be revised as quickly as the software Support Disk).

2-3-4: MOTOR CONTROL CONNECTOR

The motor control connector (J39) on the U14C board consists of two rows of square pins, each row has 40 pins for a total of 80 pins. Fourteen of the pins are User definable I/O which can be used to synchronize motor movement to external events. (See Figure 2-3A for "Pin-Out" specifications.)

The other 64 pins can be considered as 4 logical sets of 16 pins. Each set is used for an individual axis.

The 16 pins of an axis set are as follows: Step Output, +5 Volts Output, Auxiliary Output, Direction Output, Clockwise Limit Switch Input, Ground, Home Switch Input, Counter-Clockwise Limit Switch Input, and, Index +, +5 Volts, Phase A -, Phase A +, Index -, Ground, Phase B -, Phase B +.

NOTE: **The User typically need not concern himself with these Pin Out specifications since the "Interconnect Cable" shown in Figure 1-1 is provided for interconnection between the J14 Control Board and Drive Chassis.**

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DESCRIPTION	PIN	PIN	DESCRIPTION
User I/O 0	1	41	+5 volts
User I/O 2	2	42	User I/O 1
User I/O 4	3	43	User I/O 3
User I/O 6	4	44	User I/O 5
User I/O 8	5	45	User I/O 7
User I/O 10	6	46	User I/O 9
User I/O 12	7	47	User I/O 11
User I/O 13	8	48	Ground
X phase A+	9	49	+5 volts
X phase A-	10	50	X index +
X phase B+	11	51	Ground
X phase B-	12	52	X index -
Y phase A+	13	53	+5 volts
Y phase A-	14	54	Y index +
Y phase B+	15	55	Ground
Y phase B-	16	56	Y index -
X direction output	17	57	+5 volts
X auxiliary output	18	58	X step output
X CCW limit switch	19	59	Ground
X home switch	20	60	X CW limit switch
Y direction output	21	61	+5 volts
Y auxiliary output	22	62	Y step output
Y CCW limit switch	23	63	Ground
Y home switch	24	64	Y CW limit switch
Z direction output	25	65	+5 volts
Z auxiliary output	26	66	Z step output
Z CCW limit switch	27	67	Ground
Z home switch	28	68	Z CW limit switch
T direction output	29	69	+5 volts
T auxiliary output	30	70	T step output
T CCW limit switch	31	71	Ground
T home switch	32	72	T CW limit switch
Z phase A+	33	73	+5 volts
Z phase A-	34	74	Z index +
Z phase B+	35	75	Ground
Z phase B-	36	76	Z index -
T phase A+	37	77	+5 volts
T phase A-	38	78	T index +
T phase B+	39	79	Ground
T phase B-	40	80	T index -

Figure 2-3A: J39 Encoder Input and I/O Pin Assignment

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SECTION 2-4: UNIDEX 14 INTERFACE BOARD

2-4-1: JUMPER CONFIGURATIONS

NOTE: **Aerotech Inc. has configured the Unidex 14 at the time of assembly, per Customer specifications. The following sections provide jumper configuration information to be used only if the system specifications have changed since the time of manufacture.**

Refer to Figure 2-4 for Unidex 14 Interface Board Jumper information.

2-4-1-1: INPUT VOLTAGE

The desired AC input voltage may be configured by the following jumper configurations:

For 115 VAC (standard) operation -
Insert JP1,JP3
Remove JP2,JP4

For 230 VAC (optional) operation -
Insert JP2,JP4
Remove JP1,JP3

2-4-1-2: OPTIONAL ENCODER FEEDBACK

If encoder feedback to the Unidex 14 is desired it must be jumpered for either an analog sine wave or a TTL logic encoder.

All axes with an analog sine wave encoder must have a sine wave encoder terminal board (Aerotech dwg. no. 690D1333) installed. Axes jumpers must be configured as follows for an analog sine wave encoder or TTL logic encoderas follows:

X Axis	Sine Wave	Logic
JP20	connect 1-2, 2-3 removed	connect 2-3, 1-2 removed
JP21	"	"
JP22	"	"
JP23	"	"

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Y Axis	Sine Wave	Logic
JP30	connect 1-2, 2-3 removed	connect 2-3, 1-2 removed
JP31	"	"
JP32	"	"
JP33	"	"

Z Axis	Sine Wave	Logic
JP40	connect 1-2, 2-3 removed	connect 2-3, 1-2 removed
JP41	"	"
JP42	"	"
JP43	"	"

T Axis	Sine Wave	Logic
JP50	connect 1-2, 2-3 removed	connect 2-3, 1-2 removed
JP51	"	"
JP52	"	"
JP53	"	"

2-4-1-3: INPUT/OUTPUT BITS OR SYSTEM CONTROL

2-4-1-3-1: I/O BIT 5 OR AT HOME

I/O Bit 5 may be used as an Opto-Isolated INPUT by configuring JP17 with 2-3 connected, 1-2 removed. I/O Bit 5 may also be used as an indicator as to when all axes have completed their Home cycle (see I/O Bit 13) by configuring JP17 with 1-2 connected, 2-3 removed.

2-4-1-3-2: I/O BIT 6 OR FAULT

I/O Bit 6 may be used as an Opto-Isolated INPUT by configuring JP6 with 2-3 connected, 1-2 removed. I/O Bit 6 may also be used to sense Drive fault conditions by configuring JP6 with 1-2 connected, 2-3 removed. Once configured in this manner, if any of the four axis faults, this bit becomes true. See Chapter 6 for a description of the Drives having a Fault Output.

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2-4-1-3-3: I/O BIT 7 OR CZ INPUT (IN POSITION)

I/O Bit 7 may be used as an Opto-Isolated INPUT by configuring JP16 with 2-3 connected, 1-2 removed. I/O Bit 7 may also be used as an indicator as to when all of the Servo Drives have completed their move by configuring JP16 with 1-2 connected, 2-3 removed. Once configured in this manner, when all Servo Drives have completed their move, this bit becomes true.

LO/HI or the CZ Select Jumpers 12-15 must be configured appropriately in accordance with Item 2-4-1-5 when I/O Bit 7 is configured in this manner.

2-4-1-3-4: I/O BIT 12 OR LOCAL/REMOTE

I/O Bit 12 may be used as an Opto-Isolated OUTPUT by configuring JP7 with 2-3 connected, 1-2 removed. Also JP18 with 1-2 connected, 2-3 removed, JP19 with 2-3 connected, 1-2 removed sets the standard active state which may be changed by setting JP19 with 1-2 connected, 2-3 removed. I/O Bit 12 may also be configured to select operation of the drives from a Remote Clock and Direction source through the Auxiliary connectors (per axis) on the rear of the Unidex 14 Interface Board. I/O Bit 12 is configured in this manner by setting JP7 with 1-2 connected, 2-3 removed, JP18 with 2-3 connected, 1-2 removed and JP19 with 1-2 connected, 2-3 removed.

The Local mode must be active to control the axis from the Unidex 14's Clock and Direction commands (this is the default state upon power up).

2-4-1-3-5: I/O BIT 13 OR GO HOME (HARDWARE HOME)

I/O Bit 13 may be used as an Opto-Isolated OUTPUT by configuring JP5 with 2-3 connected, 1-2 removed. I/O Bit 13 may also be configured to trigger the Driver's hardware home circuit of all axes simultaneously by setting JP5 with 1-2 connected, 2-3 removed.

2-4-1-4: AXIS AUXILIARY OUTPUTS (LO/HI CURRENT CONTROL)

Each axis (X,Y,Z,T) has an Auxiliary Output (JP11, JP10, JP9 and JP8 respectively) which may be used as an Opto-Isolated OUTPUT. The Auxiliary Outputs are synchronized to each axes motion by configuring the appropriate jumper with 1-2 connected, 2-3 removed.

LO/HI or the CZ Select Jumpers 12-15 must be configured appropriately in accordance with Item 2-4-1-5 when the I/O Bit 7 is configured in this manner. Axis Output may also be used to toggle Stepping Motors to the "Stand-By" (Lo Current) mode when at rest by setting the axes jumper with 2-3 connected, 1-2 removed.

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2-4-1-5: LO/HI CURRENT CONTROL OR CZ SELECT (IN POSITION)

Each axis (X,Y,Z,T) has a jumper (JP15, JP14, JP13,JP12 respectively) for a multi-purpose signal on the Drive module. If an axis Drive module is a Stepper, the respective jumper should be configured with 1-2 connected, 2-3 removed. (See also Item 2-4-1-4.) If an axis Drive module is a DC Servo then the axes respective jumper should be configured with 2-3 connected, 1- 2 removed. (See Item 2-4-1-3-3.)

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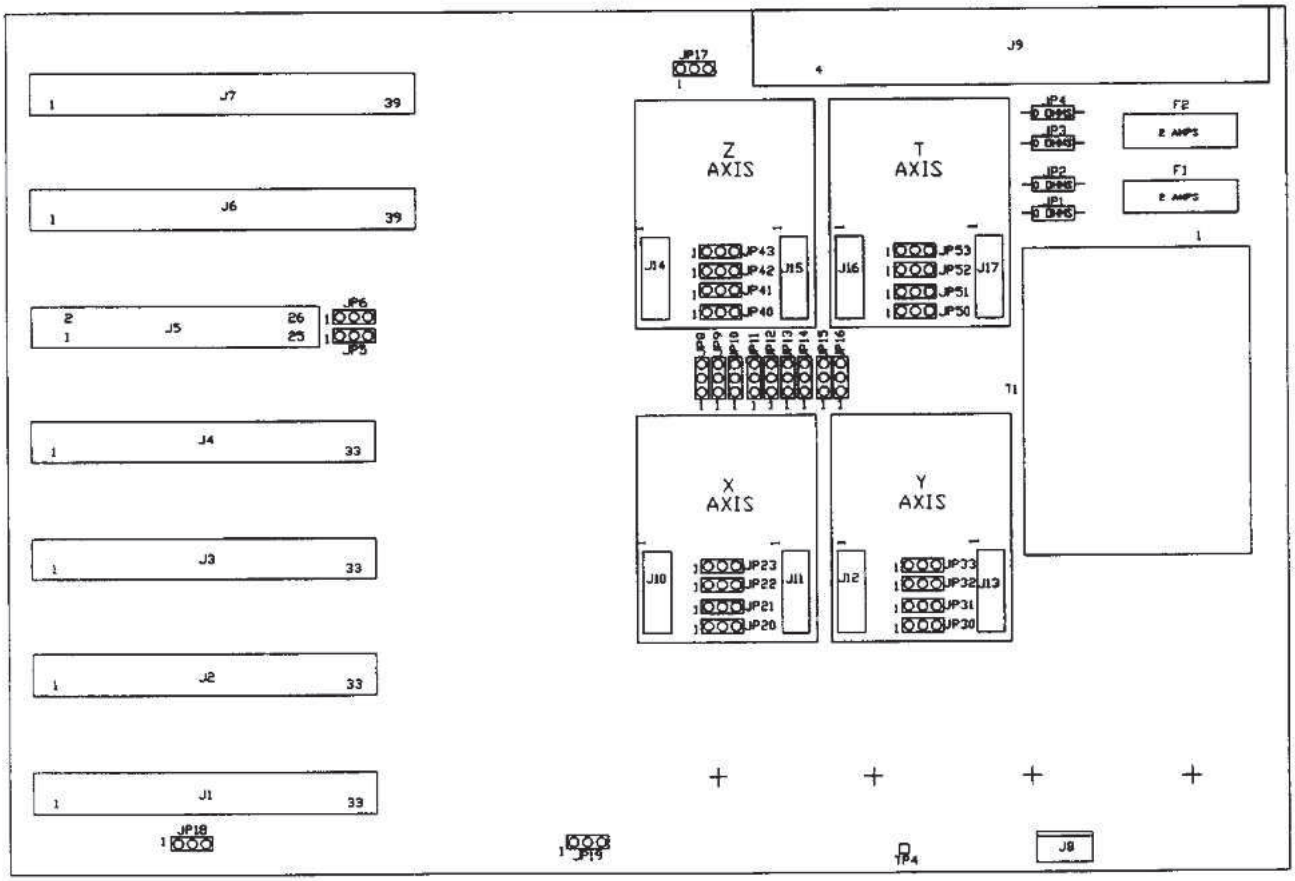


Figure 2-4: Unidex 14 Interface Board

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SECTION 2-5: VELOCITY PROFILES

2-5-1: FUNCTIONAL DESCRIPTION

The Unidex 14, in response to commands from the host computer, provides controlled acceleration to a predefined peak speed followed by calculating the optimum velocity 1024 times each second providing a very smooth acceleration curve. This calculation is used to control a variable frequency pulse train which is derived from a crystal oscillator providing very accurate pulse rates.

The 68000 microprocessor calculates this velocity profile for each of the axes providing independent but synchronized (if desired) profiles for each axis. The Unidex 14 can perform a smooth coordinated move on all four axes using linear, parabolic or cosine velocity profiles. It can manage four independent or coordinated processes.

The Unidex 14 will calculate the optimum velocity profile to generate the desired move while conforming to the acceleration and velocity data input by the host computer. This move will consist of a smooth acceleration followed by a constant velocity section and a smooth deceleration to the desired distance. A graph of a typical linear velocity is shown in Figure 2-5.

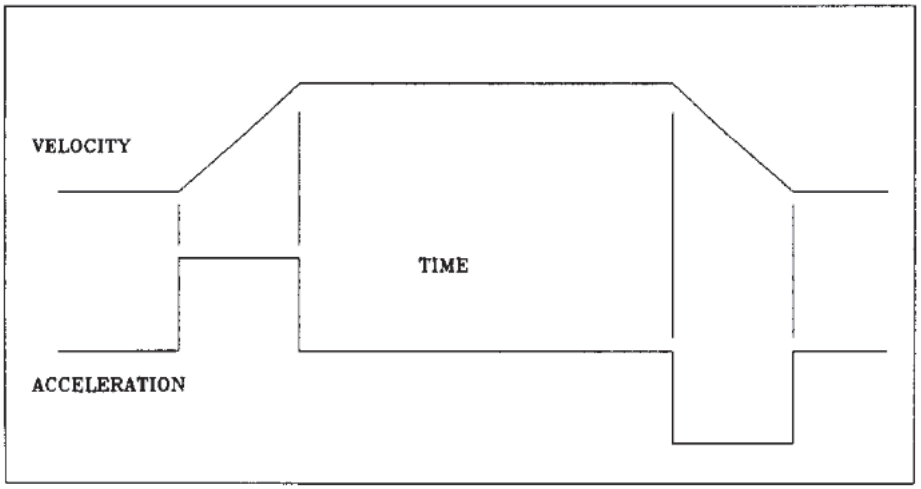


Figure 2-5: Typical Velocity Profile

If the move parameters do not allow the motor to accelerate to the desired velocity in the desired distance, the Unidex 14 will automatically generate an optimum triangular velocity profile. It can also be commanded to accelerate to a velocity and hold that velocity until told to stop or change to a new velocity. It will then smoothly decelerate to a stop or accelerate/decelerate to the new velocity.

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Several moves of this type may be chained together to provide a more complex pattern. The Unidex 14 is able to store up to 124 characters in an input character buffer and 200 commands and parameters in separate command queues for each axis allowing several moves to be made without host intervention. A loop counter is provided to repeat desired sections of a complex move pattern. Loops may be nested up to four levels deep on all axes.

2-5-2: VELOCITY PROFILE OPTIONS

The Unidex 14 Motion Controller offers three options for ramping the device to speed. The traditional constant acceleration or linear velocity ramp (Figure 2-5) is the default on reset or power up. The half sinusoid acceleration or half cosine velocity ramp (Figure 2-7) is selected by the CN command. Since the acceleration is zero at the velocity inflection points, this provides very smooth operation. It is used in sensitive applications such as wafer handling on a vacuum chuck. The third option is a reverse ramp of acceleration or Parabolic Velocity curve (Figure 2-6) which can be selected by the PN command. This ramp is commonly used to compensate for loss of motor torque at high speeds, i.e. since the acceleration is reduced at higher speeds the required forces are reduced proportionally. This type of ramping is suitable for open-loop stepping motor control where as linear and half sinusoid's moves are suitable for DC Brush or Aerodrive control. The parabola may be truncated to allow the user to select, under program control, the reduction in acceleration (force) appropriate for the application.

2-5-2-1: LINEAR RAMPS

The Unidex 14 Motion Controller generates a linear velocity ramp in real time, i.e. while the stage is in motion. There is no table building prior to the move and thus minimal latency. The controls will accelerate to the specified velocity and hold that speed until just enough move distance is left, then decelerate to a stop. If the move distance is too short to reach speed, a triangular velocity ramp will automatically be generated. The acceleration is a constant A_m and the velocity is then:

$$v = A_m t$$

A useful relationship in the distance required to accelerate at acceleration A_m to peak velocity V_p is as follows:

$$s = \frac{\pi V_p^2}{2A_m}$$

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or the acceleration A_m required to accelerate to peak velocity Vp in distances s is as follows:

$$A_m = \frac{V_p^2}{2s}$$

2-5-2-2: PARABOLIC RAMPS

The parabolic ramp is generated in a similar fashion except the acceleration is reduced as the stage accelerates to speed thus reducing the velocity slope as shown in Figure 2-6.

The acceleration follows the equation:

$$a = A_0 - A_0 \frac{t}{T_2}$$

and the velocity is then:

$$v = A_0 t - \frac{A_0 t^2}{2T_2}$$

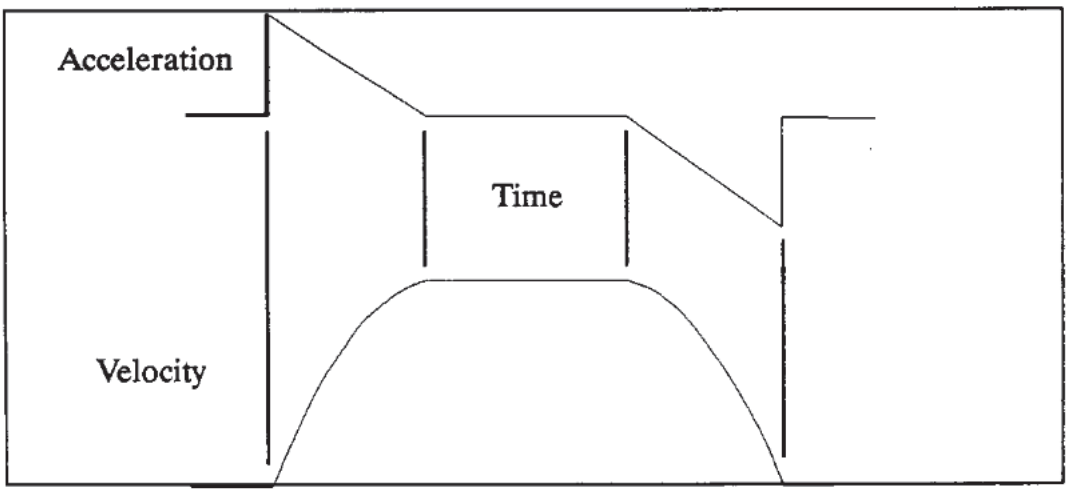


Figure 2-6: Parabolic Velocity Profile

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and the distance traveled in the ramp is:

$$s = \frac{A0t^2}{2} - \frac{A0t^3}{6T2}$$

where $A0$ is the initial acceleration, t is time during the ramp and T2 is total ramp time if the acceleration $\frac{t}{T2}$ had reached zero. The parameter supplied with the PN command is 10 times the ratio which can take on values from 3 to 10, allowing the final acceleration to range from 70% to 10% respectively of the programmed or initial value. When a move is specified, the controls will fit the resulting velocity curve to the desired acceleration profile. This insures that the desired acceleration is always reached at the programmed velocity as long as the move is long enough for the motor to reach the programmed speed. If the move is too short to reach the programmed speed the curve is truncated causing the shape of the velocity curve to remain the same up to the velocity reached by the specific move. This is consistent with the desired result of compensating for loss of motor torque since the motor has not reached the programmed speed, less compensation is needed. The parabolic ramp mode may result in reduced move time at high speeds, since a larger acceleration may be used.

2-5-2-3: COSINE RAMPS

The cosine ramps are generated in a similar fashion to the parabolic ramps, except the acceleration is:

$$a = Am \sin \frac{2Am}{Vp}$$

and the velocity is then:

$$v = \frac{Vp}{2} (1\text{-}\cos \frac{2Am}{Vp} t)$$

and the distance traveled in the ramp is:

$$s = \frac{Vp}{2} t \frac{Vp^2}{4Am} \sin \frac{2Am}{Vp} t$$

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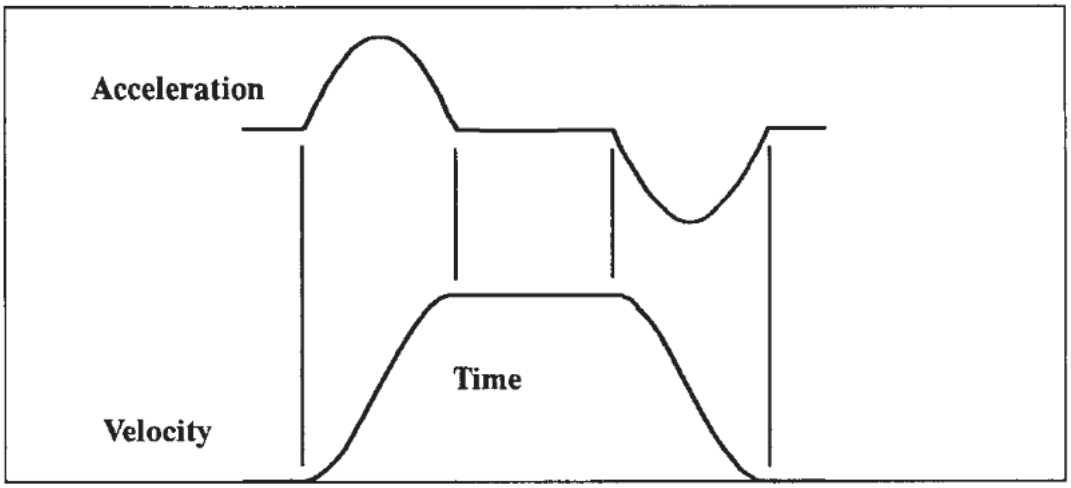


Figure 2-7: Cosine Velocity Profile

where V_p is the peak velocity, Am is the peak acceleration. The distance needed to ramp up is then:

$$S1 = \frac{\pi V_p^2}{4Am}$$

and the time required to ramp up is:

$$T = \frac{\pi V_p}{2A_m} = \sqrt{\frac{\pi S_1}{A_m}}$$

and the peak velocity is:

$$V_p = \sqrt{\frac{4A_m S_1}{\pi}}$$

The cosine ramp requires $\frac{pi}{2}$ times longer than a linear ramp to reach the same velocity when using the same peak acceleration.

Since the purpose of the cosine ramp is smooth operation, it is desirable to adjust the velocity parameters such that the desired profile is achieved even when the stage does not reach the programmed speed as opposed to truncating the curve as is done with the Parabolic curves.

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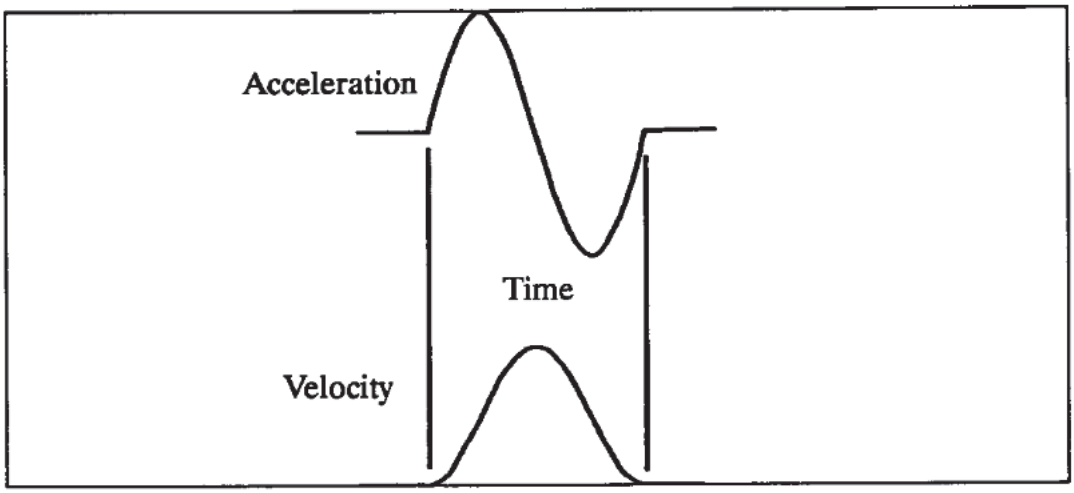


Figure 2-8: Short move Cosine Velocity Profile

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CHAPTER 3: I/O CHANNEL INTERFACE

SECTION 3-1: I/O CHANNEL

The PC and XT system bus has available several slots for interfacing I/O cards such as the U14C. The AT has an additional connector to make available the 16 bit data bus and additional address lines. Since the U14C is an I/O device, it uses only the low order 8 bits of the data bus and the first 10 address lines in this family of computers. It can thus be used in any computer which meets the IBM I/O channel specification. The following table shows the I/O channel signals which are also the descriptions of the pins on the edge connector of the U14C board. The front or component side of the board is the A side of the connector of the U14C while the back or solder side is the B side.

3-1-1: PC/XT/AT DATA BUS.

The data bus is an 8 bit, bidirectional, 3-state bus. Direction of data is controlled by the PC/XT/AT host computer. The data bus uses high-level active logic. All data and commands are passed through this data bus. (See Figures 5-3 and 5-4)

3-1-2: PC/XT/AT ADDRESS BUS.

The address bus is a 20-bit high-level active bus. This bus is always driven by the PC/XT/AT host computer. The address bus provides the 20 address lines for decoding by either memory or I/O. (See Figures 5-3 and 5-4)

3-1-3: MEMORY AND I/O CONTROL

These lines provide the signals for fundamental memory and I/O operations. MEMW, MEMR, IOW and IOR control lines distinguish between memory and I/O transfers and determine the direction of transfer. Since the U14C is an I/O device it uses only A0 through A9 and only IOW and IOR to determine the direction of transfer. (See Figures 5-3 and 5-4 and Table 3-1)

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3-1-4: INTERRUPT REQUEST

The PC/XT/AT supports interrupts to the system bus at levels 2 (IRQ2) through 7 (IRQ7). These are active high input only signals to the system bus. They go directly to the system interrupt controller which generates the vector during an interrupt acknowledge cycle. The U14C supports all 5 interrupt levels which can be selected by a jumper at J17. Refer to Section 3-3 for details of configuration. (See also Figure 5-4)

Table 3-1 Control Line Description

SIGNAL	DESCRIPTION
MEMW*	This is a low level active signal used to write data from the system bus into memory and is thus not used by the U14C.
MEMR*	This is a low level active signal used to read data from memory to the system bus and is thus not used by the U14C.
IOW*	This is a low level active signal used to write data into I/O. It is driven by the system bus and indicates the address bus contains a valid I/O address. It is used by The U14C as an address qualifier for write operations.
IOR*	This is a low level active signal used to read data from an I/O device onto the system bus. It is driven by the system bus and indicates the address bus contains a valid I/O address. It is used by the U14C as an address qualifier for read operations.
ALE	This output only signal driven by the system bus is decoded by the U14C to indicate a valid address on the system bus.

* Indicates low true signal

3-1-5: DIRECT MEMORY ACCESS

The PC/XT/AT supports DMA levels 1 and 3 on the system bus. DRQ1 through DRQ3 are active high input only request lines while DACK1 through DACK3 are active low level output only signals issued by the system to acknowledge the DMA request. AEN is also decoded by the U14C as required to decode the DMA transfer operation. The U14C supports levels 1 and 3 in either the read or write direction. The level is selected via J17. Refer to Section 3-4, for configuration details. The direction of transfer is under software control, see Chapter 4, for an example program.

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3-1-6: CLOCK AND OSC LINES

These are provided on the system bus. The U14C has its own on-board clock and does not use either of these signals.

3-1-7: RESET DRV

This line is a reset driver which is provided on the bus. The U14C has an on board reset timer and uses the RESET DRV signal to initiate this timer on power up or during a system reset. This bus signal is not active during a warm boot such as the CTL-ALT-DEL or CTL-BREAK and thus the U14C is not reset. It can, however be reset on computers equipped with a reset push button.

3-1-8: I/O CH RDY

This line is used in conjunction with memory wait state generation. It is not used by the U14C since wait states are not required.

3-1-9: I/O CH CK

This signal is used in conjunction with data parity checking. It is not used since parity is not checked by the U14C.

A Table of "Pin-Out's" for the 8 Bit I/O channel is shown in Table 3-2.

SECTION 3-2: ADDRESS SELECTION

The U14C is operated as an I/O mapped device. Each board occupies a block of 4 contiguous I/O addresses. The factory default addresses are from base address 300 through 303 hex. (Refer to Figure 2-1) The actual address is chosen by jumpers on J15. Connecting a jumper selects a 0 for that address bit, while no jumper selects a 1. (See Section 2-3)

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Table 3-2 I/O Channel Connector Pin List

PIN	DESCRIPTION	PIN	DESCRIPTION
B1	Ground	A1	I/O CH CK
B2	Reset Dry	A2	D7
B3	+5 Volt	A3	D6
B4	IRQ2	A4	D5
B5	-5 Volt	A5	D4
B6	DRQ2	A6	D3
B7	-12 Volt	A7	D2
B8	Unused	A8	D1
B9	+ 12 Volt	A9	D0
B10	Ground	A10	IO CH RDY
B11	MEMW*	A11	AEN
B12	MEMR*	A12	A19
B13	IOW*	A13	A18
B14	IOR*	A14	A17
B15	DACK3	A15	A16
B16	DRQ3	A16	A15
B17	DACK1	A17	A14
B18	DRQ1	A18	A13
B19	DACK0	A19	A12
B20	CLK	A20	A11
B21	IRQ7	A21	A10
B22	IRQ6	A22	A9
B23	IRQ5	A23	A8
B24	IRQ4	A24	A7
B25	IRQ3	A25	A6
B26	DACK2	A26	A5
B27	T/C	A27	A4
B28	ALE	A28	A3
B29	+5 Volts	A29	A2
B30	OCS	A30	A1
B31	Ground	A31	A0

* Indicates low true signal

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SECTION 3-3: USING INTERRUPTS

Full interrupt capability is provided by the U14C in accordance with the I/O channel specification. Interrupts for input buffer full (IBF), transmit buffer empty (TBE), over-travel fault and operation complete are provided. Interrupt levels 2 through 7 are jumper selectable at J17. Polled operation is also supported with separate status bits for each of the above sources. Table 3-3 shows the detail of the level select jumpers on J17.

NOTE: **The "C demonstration program with interrupts" illustrated in Section 9-5 provides a good example of interrupt use.**

Table 3-3 Interrupt Level and DMA Selection Jumpers

DESCRIPTION	PIN	PIN	DESCRIPTION
Local DACK	1	20	DACK3
Local DACK	2	19	DACK1
Local DRQ	3	18	DRQ3
Local DRQ	4	17	DRQ1
Local IRQ	5	16	IRQ7
Local IRQ	6	15	IRQ6
Local IRQ	7	14	IRQ5
Local IRQ	8	13	IRQ4
Local IRQ	9	12	IRQ3
Local IRQ	10	11	IRQ2

SECTION 3-4: DMA

Full DMA operation is supported for either reading or writing to the U14C on levels 1 or 3. The preceding table shows the detail of the level select jumpers (J17). Refer to Host Software Section for software details. For an example of a controlling Unidex 14 under DMA control refer to the example program "U14_CDMA.C' on the software Support Disk provided).

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SECTION 3-5: I/O REGISTERS

The U14C Control Board occupies 4 contiguous addresses in PC/XT/AT I/O space. The registers associated with each address are described in the following table.

Table 3-4 I/O Register Description

ADDRESS OFFSET	FACTORY DEFAULT	DESCRIPTION
0	300 hex	Data register
1	301 hex	Done flag register
2	302 hex	Control register
3	303 hex	Status register

3-5-1: DATA REGISTER

The data register is the data communication port between the U14C and the PC/XT/AT or compatible host. All data is passed between the host processor and the U14C 68000 processor through this port. This port is full duplex and double buffered in both directions allowing data to be written to the port before the previous byte has been read and processed. This allows for faster processing of the data between the two microprocessors.

3-5-2: DONE FLAG REGISTER

This is a read only register from the U14C. The status bit indicating the done status of each axis is written by the 68000 on the U14C. The host can then read it at any time to determine the status of the motion process. It is cleared by reading the register. The bit definition is shown in Table 3-5.

Table 3-5 Done Flag Register Description

DONE STATUS REGISTER DESCRIPTION	
BIT	DESCRIPTION
0	Done status of X axis
1	Done status of Y axis
2	Done status of Z axis
3	Done status of T axis
4	(Undefined)
5	(Undefined)
6	(Undefined)
7	(Undefined)

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3-5-3: INTERRUPT AND DMA CONTROL REGISTER

This read/write register allows different interrupt sources from the U14C to be individually enabled or disabled. This may be performed at any time by a write to this register. It also allows DMA requests to be generated when the IBF or TBE flags are set and enabled. DMA can be requested for only one data transfer direction at a time. The register may be read back to verify or determine the state of the interrupts.

Table 3-6 Control Register Description

BIT	NAME	CONTROL DESCRIPTION
7	IRQ_E	Interrupt enable bit. This bit must be on to enable any interrupts.
6	TBE_E	Transmit buffer empty interrupt enable bit. This bit should be checked before writing to the data register to avoid sending a character when the interrupt has been disabled.
5	IBF_E	Input buffer full interrupt enable bit
4	DON_E	Done or error status interrupt enable bit
3	Unused	
2	Unused	
0	DMA_DIR	DMA direction for requests. A 0 indicates DMA will be requested for transfers from the host to the U14C board and a 1 indicates transfers from the U14C board to the host.
1	DMA_E	Enable DMA requests. A 1 will enable DMA requests when the appropriate data transfer is requesting service.

3-5-4: STATUS REGISTER

The status register is a read only register that provides status information to the host CPU. This status is independent of the enable status of the interrupt, allowing the board to operate in a polled mode if desired.

In order to resolve the source of a done or error interrupt, the DON_S bit (bit 4) should be read first. This bit in the status register is automatically reset upon reading the status register. If DON_S flag is true, the error bits should then be read to determine if the interrupt was caused by an error condition. If no error condition is present then the done flag register can be read to determine which axes are done. An "IC" command (or control-Y is preferred) should then be given from within the interrupt service

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routine or poll routine to reset the done flag register and error bits. The TBE_S bit is reset by writing to the data register and the IBF_S bit is reset by reading the data register. Both bits may remain true after a single read or write since the data port is double buffered and may still remain ready for data.

SECTION 3-6: POWER SUPPLY REQUIREMENTS

The U14C is designed to operate from the power supplied in the PC/XT/AT backplane. The host computer or expansion box must be capable of supplying 2.5 amps maximum for operation of the U14C board.

Table 3-7 Status Register Description

BIT	NAME	CONTROL DESCRIPTION
7	IRQ_S	Interrupt request status.
6	TBE_S	Transmit buffer empty status. This high true bit indicates a character may be written to the input buffer of U14.
5	IBF_S	Input buffer full status. This high true bit indicates a character is available in the output buffer of U14.
4	DON_S	Done or error status. This high true bit indicates the command is complete i.e. and ID command has been executed or an error has been detected. If bits 0-3 are all false it indicates a command completion i.e. an ID command has been executed. The error bits indicate one or more errors have been detected.
3	OVRT	Overtravel. An overtravel switch was true indicating attempted travel out of bounds.
2	ENC_S	Encoder error. This bit flags a slip error on models with the encoder option if the interrupt on slip (IS) command has been issued.
1	INIT	Init flag. This bit indicates the U14C is being reset or the 68000 microprocessor has not completed initialization. Host initialization routines should check this bit for a zero before proceeding.
0	CMD_S	Command error. An unrecognizable command has been detected or LS or LE commands are not in matched pairs.

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CHAPTER 4: CHASSIS, I/O AND DRIVER INTERFACE

SECTION 4-1: INTRODUCTION

This chapter describes the various Unidex 14 Chassis interface connections.

The drive modules available that interface to the Unidex 14 are:

Stepping Motor Drive Modules:

- **D1401**
- **DM1501**
- **DM4005**
- **DMV8008**
- **D3001**
- **DM4001**
- **DM6006**
- **DMV16008**

DC Motor Drive Modules

- **DSL8020**
- **DSL3015**
- **DSL16020**
- **DSL4020**

Aerodrive

- **DAV4008**
- **DAV16008**

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SECTION 4-2: UNIDEX 14 REAR PANEL CONNECTIONS

An outline drawing for the rear panel of the Unidex 14 Driver Chassis is shown in Figure 4-1A and 4-1B.

Control and Power connections for both chassis shown in Figure 4-1. A brief description of the various connectors is outlined below:

XJ1,YJ1,ZJ1,TJ1

Power connection motor connectors.

J13,J14,J19*,J20*

Limit, Marker, and, for the DC Servo Control, Encoder interface connectors for the X,Y,Z and T drives.

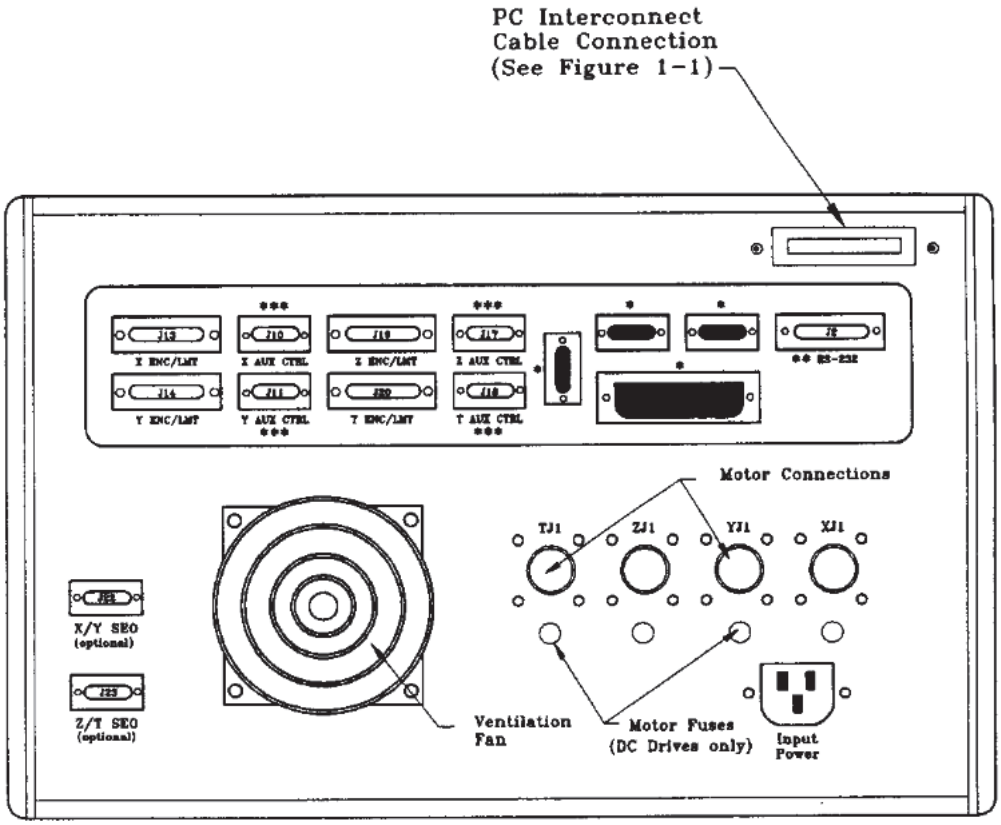
J10,J11,J17*,J18*

Auxiliary control connections for the X,Y,Z and T drives. The use of these connectors depends on the type of Unidex 14 chassis used. See Section 4-3.

** Application for 4 Axis chassis, U14R, U14S and U14H*

J3	N/A
J5	N/A
J2	I/O
J15	N/A
J6	N/A
J25	N/A
J22,J23	These connectors are supplied for the Serial Output (SEO) Option for Unidex 14. These optional connectors provide opto-coupled positioning data and status output signals relative to X,Y,Z and T axes.

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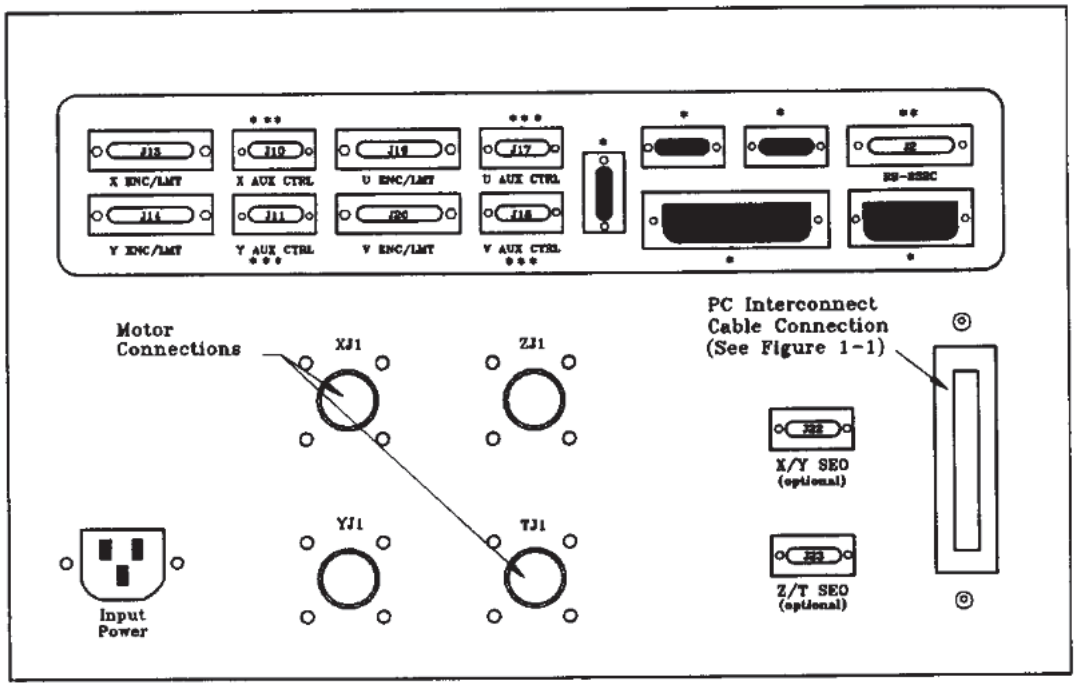
* NOTE: Connectors are present but not used.

** NOTE: J2 is labeled as RS-232. The Unidex 14 however, uses this connector as an I/O connection.

*** NOTE: These connections are used for linear encoder interface and Aux. control.

Figure 4-1A: Rear Panel Outline of Unidex 14 Four Axis Desktop & 19" Rack Chassis (Models U14S & U14R)

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* NOTE: Connectors are present but not used.

** NOTE: J2 is labeled as RS-232. The Unidex 14 however, uses this connector as an I/O connection.

*** NOTE: These connections used for linear encoder interface.

Figure 4-1B: Rear Panel Outline of the Unidex 14 Four Axis Heavy-Duty 19" Rack Chassis (Model U14H)

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4-2-1: UNIDEX 14 CONTROL CONNECTIONS

The external control connectors shown in Figure 4-1 are detailed in Figure 4-2. Aerotech supplies the mating connectors for each external control connector upon request.

For convenience, a list of mating connectors and their manufacturer is presented in Table 4-1:

Mating connector for 25 pin "female" "D" connectors J13,J14,J19 and J20	Molded cable type "male", Beldon, No. 49670 Solder pot type "male", TRW-CINCH,No. DBM-25P Ribbon connector type "male", TRW-CINCH, No. FC25P
Mating connector for 25 pin "male" "D" connector J2	Molded cable type "female", Beldon, No. 49675 Solder pot type "female", TRW-CINCH, No. DBM-25S Ribbon connector type "female" TRW-CINCH, No. FC25S
Mating connector for 15 pin "male" "D" connectors J10,J11,J17,J18,J22,J23	Molded cable type "female", Beldon, No. 49727 Solder pot type "female", TRW-CINCH, No. DAM-15S Ribbon connector type "female", TRW-CINCH, No. FC15S

Table 4-1: List of Mating Connectors for External Control Connectors

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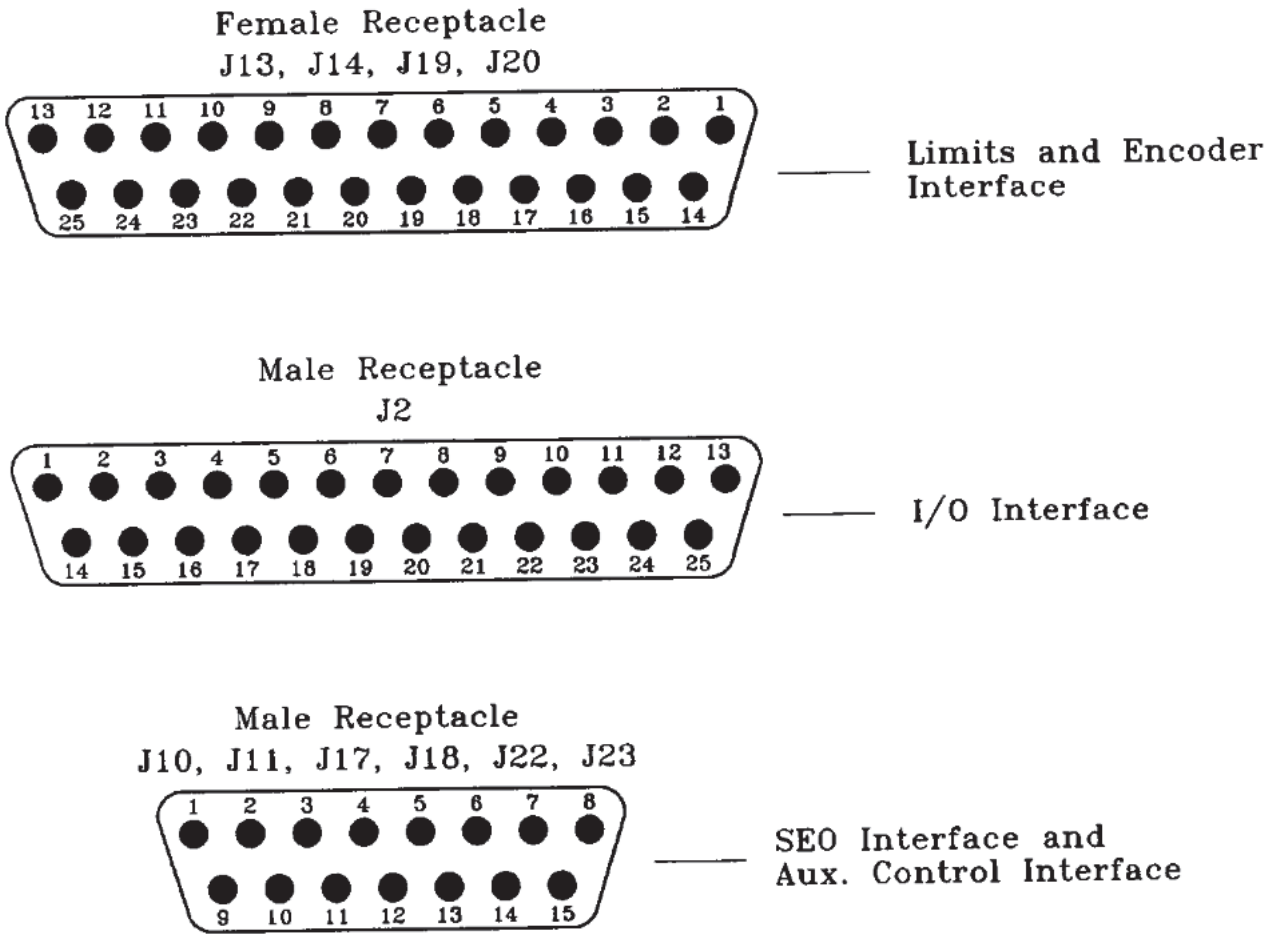


Figure 4-2: Outline of Unidex 14 External Control Connectors

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4-2-2: LIMIT SWITCH, MARKER AND ENCODER

Connections for X,Y,Z,T Drives

The following section describes the external control connections of the Unidex 14 (See Figures 4-1A, 4-1B and 4-2 for more detail).

4-2-2-1: CONNECTOR SPECIFICATION

J13,J14,J19 and J20 for U14S,U14R and U14H Drive Chassis

Connectors J13, J14, J19 and J20 provide for the termination of the basic control interface signals between the X,Y,Z and T Aerodrive, Stepping Motor and/or DC Servo Motor and the Unidex 14. Motor travel limits and homing signals for each axis are terminated at these receptacles, as well as Encoder signals for DC Motor and Aerodrive control. Encoder tracking for open loop stepping control. The pinouts are as follows (See Figure 4-2 for receptacle outline).

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J13,J14,J19 and J20 (U14S,U14R and U14H Chassis):

Pin #	Description	Comments
	FORM C	FORM A (normally open) or FORM B (normally closed)
13 *	CW Limit (in)	No Connection
12 *	/CW Limit (in)	/CW or CW Limit (in)
25 *	/CCW Limit (in)	No Connection
24*	/CCW Limit (in)	/CCW or CCW Limit (in)
23 *	Home Limit (in)	No Connection
22 *	/Home Limit (in)	/Home or Home Limit (in)
7	Marker (in)	Encoder Marker (or Index Pulse, see following diagram) for DC Servo Motor or separate marker (Index Pulse for Stepping Motor control).
6	/Marker (in)	
3,16	+5VDC (200mA max)	For Encoder only.
9,20,21		(No connection)
	Signal Common	
4	Optional +5VDC (For Aerotech use only)	
1	Shield (Connector Retaining Screws are also connected to chassis frame)	
14	COS (in)	Encoder quadrature signals (see following diagram).
15	/COS (in)	
17	/SIN (in)	
18	SIN (in)	
19	+ Tach Input	Optional Tach for DC Servo only Polarity indicated for CW Motor rotation
8	- Tach Input	

* Form C Limit connections are "factor select" only. Form A Limit connections are the standard configuration shipped. Form B Limit connections can be field selected on the given DC or Stepping Drive module.

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Encoder Input Specifications:

The Encoder feedback option is intended primarily for applications where desired positional accuracy exceeds the accuracy of the mechanical drive components (for example; lead screws) or position feedback is required to detect motor slip or stall. The Encoder Interface is required for DC Brush and Aerodrive Systems. It is optional for open loop stepping systems.

NOTE: Encoder position verification commands (See Sections 8-13, 8-14, 8-15 and 8-16) may optionally be used for DC Brush and Aerodrives. The DC Brush and Aerodrive Systems use the encoder internally to close the servo (positions) loop.

Unidex 14 accepts quadrature pulse outputs from high resolution encoders. Up to 50,000 pulse per revolution encoders may be used while the indexers are generating pulses at their maximum rate. This allows position feedback information to match the resolution to the microstepping motor drive.

Times four quadrature detection is used to increase resolution. The inputs are compatible with encoders which have single ended TTL outputs as well as differential line drivers. Provisions are also provided for an index pulse (differential or single ended).

The user can specify the encoder count/motor count ratio for position maintenance and encoder tracking mode. This ratio is handled internally in floating point format and can be virtually any ratio. Slip detection requires that the encoder resolution (after the 4X quadrature detection) match the motor resolution.

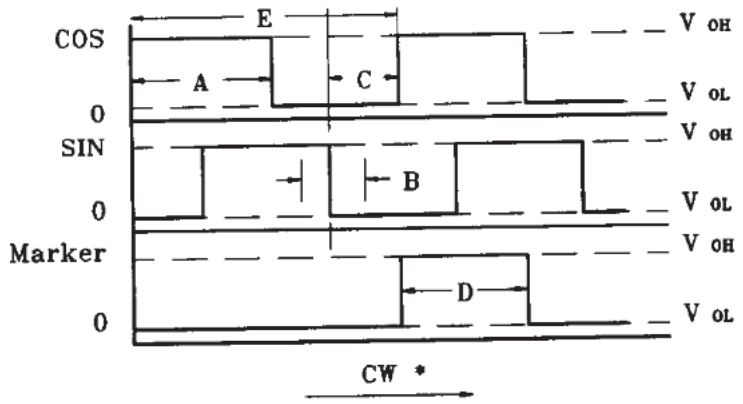
The Unidex 14 DSL8020, DSL3015, DSL4020 or DSL16020 DC Servo Modules can be factory set for:

1. Differential amplified sine wave encoder operation, or
2. Single-ended or differential square wave (line driver or TTL) encoder operation.

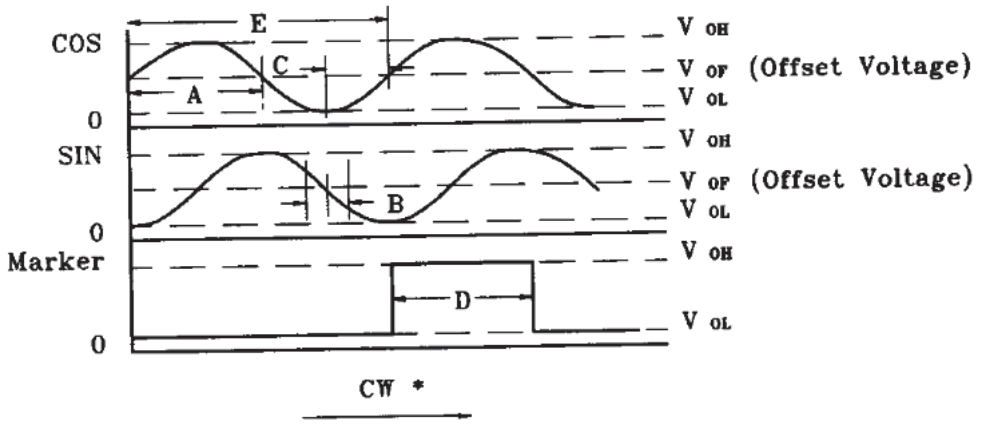
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Electrical specifications for both sine and square wave Encoder types are shown below:

Square Wave Encoder
(/COS, /SIN, and /Marker not shown, but similar)



Sin Wave Encoder
(/COS, /SIN, and /Marker not shown, but similar)



* Motor rotational reference, CW, is looking into the motor mounting flange. Encoder is assumed to be mounted on rear of motor.

NOTE: DC Brush Systems and Encoder Verification Systems can use both sin and square wave forms. However, Aerodrive Systems can only use sin wave encoders.

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Encoder Voltage Specifications:

Specification	*Sine Wave*	*Square Wave*
V OH	3.0 V MIN	2.4 V MIN
V OL	1 V MAX	.4 V MAX
V OFF	1.75 - 2.25 V TYP	-----

Encoder Timing Specifications:

Specification	*Sine Wave*	*Square Wave*
A(Symmetry)	180°±10°Max	180°±10°Max
B(Jitter) (1)	±20°Max	±5°Max
C(Quadrature) (1)	90°±20°Max	90°±20°Max
D(Marker Width) (2)	90°Min/270°Max	90°Min/270°Max
D(Period) (3)	25mSec Min (40KHz)	13.3mSec Min (75KHz)

NOTE 1: Quadrature jitter at 35 KHz.

NOTE 2: The DC Servo Drive Modules internally mask the Marker to "one" machine step, based on the logical "and" of the "positive" Sine and Cos single states.

NOTE 3: The maximum Encoder frequency stated above is based on one full output cycle of the Encoder (X1 mode). The DC Servo Drive Modules can be field selected for X1, X2, or X4 interpolation of the Encoder signals. The maximum data rate of the Unidex 14 system is 524kHz. When a sine wave Encoder is used in the X4 mode, the maximum system data rate is 160kHz. When a square wave Encoder is used in the X4 mode, the maximum system data rate would be 300kHz.

Single-ended square wave Encoders can be accommodated by appropriately connecting the Encoder to the Sin, Cos and Marker connections, while leaving the /Sin, /Cos and /Marker points unconnected. (NOTE: For "noisy" environments, differential output Encoders are recommended.)

The Marker inputs connections are applicable for Aerodrive as well as DC Servo Motor control. However, the electrical specifications for the Marker inputs (pin 7 and 6) when used with Stepping Motor control without the optional Tracking Encoder, differ from the Encoder Marker specifications just previewed for DC Servo control.

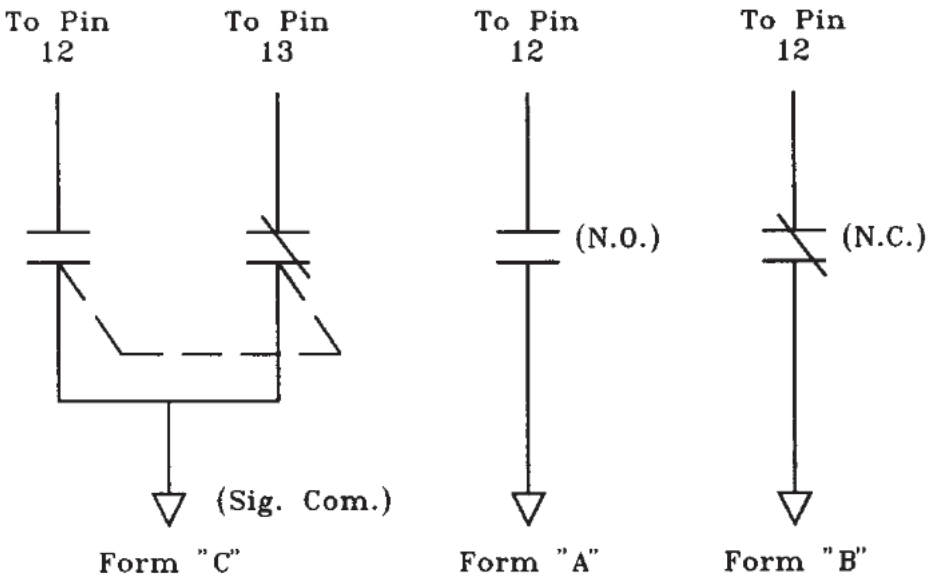
The Stepping Motor Drive Systems (ie., Drive Modules DM4005, DM6006 etc.) may be equipped with a Home Marker option (option number "HMO") that is not associated with the marker pulse of an encoder. The Internal Interface circuit for this option is shown in Section 4-2-2-2-1.

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4-2-2-2: SPECIFICATIONS FOR SECTION 4-2-2-1

Form C connections for the CW, CCW and Home Limit inputs are optional. Form A and form B connections are standard, and are connected at pins 12, 24 and 22 respectively.

Form C, form A and form B contacts are defined for the CW limit as follows (CCW and Home limits are similar).

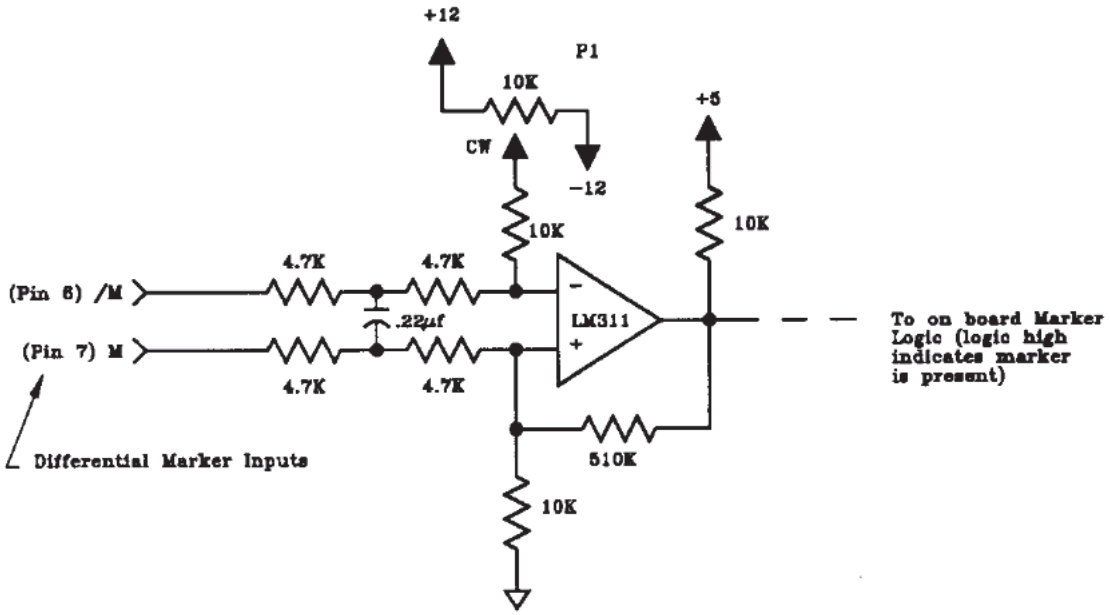


Contact Positions shown when not in limit.

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4-2-2-2-1: HOME MARKER INTERFACE SPECIFICATIONS FOR "DM" SERIES STEPPING MOTOR DRIVE

Shown below is a circuit diagram of the differential input marker circuit, for open loop stepping drives using the Home Marker options, ("HMO"). This circuit is located on the "DM" Series Stepping Drives.



Potentiometer P1 in the circuit above, allows the threshold of the marker input signal to be adjusted. The threshold level is increased by turning P1 CW. To activate the marker logic, the voltage signal at "M" must rise slightly higher than the voltage signal at "/M", plus the threshold setting at P1. In other words:

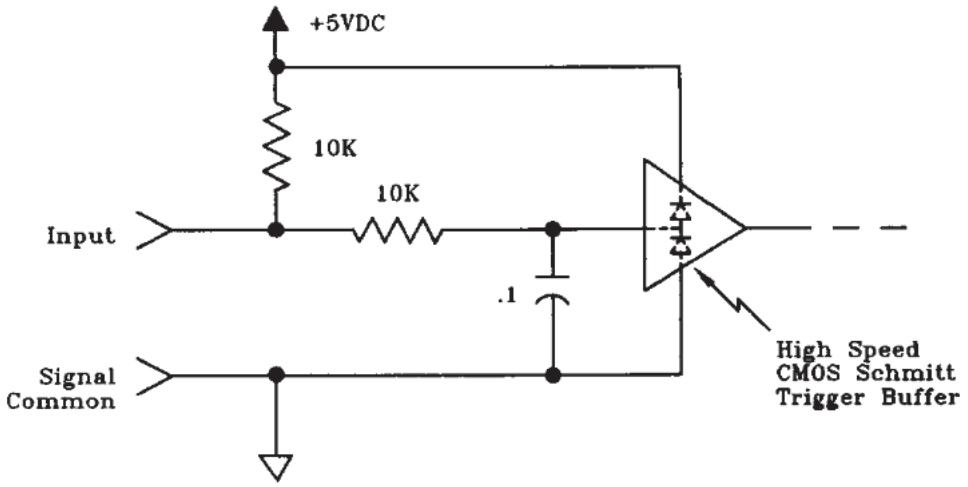
M > /M + P1 (threshold)

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When using form A or form B input connections, selections of polarity (normally open or normally closed) must be made on the appropriate module through a set of programming jumpers. (See Chapter 6 for more information)

Normally, the polarity of these limits are factory set for Form A (normally open).

All limit input configurations are internally buffered as shown below:



All limit inputs are protected against accidental over voltage of ±30 volts. All logic inputs such as dry contact, open collector, TTL, 5 to 15 volt CMOS can be used.

The maximum current draw (per axis) on the +5VDC connections (pins 3 and 16) is 200 mA.

The presence of a visual indication for acknowledging CW limit, CCW limit and Marker can be made by viewing the LED indicators on the front panel for a given axis.

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The Drive Module specifications in Chapter 6 of this manual provide more information concerning the Limit switches, the Home cycle, and Marker references.

The Limit and Home switches are contact closures or any other suitable active switch such as a hall effect switch or opto-isolator to ground. The Limit switch closure will stop the associated pulse stream if the motor travels beyond its allowable limits and trips the switch. The Home switch Limit provides a means to synchronize the motor controller with the load at some home or reference position. The Home Limit switch when used with the software HM (See Section 8-4) command will cause the motor to stop when the switch closes. On finding the home position the internal position counters will be initialized. The sense of the home switches may be changed to true when open if desired by use of the HH command. The limit switches may be changed to true when open by removing the jumper on J47 of the U14C Control Board if desired.

The Unidex 14 provides "Homing" to an initial reference in one of two ways:

First, by the utilization of the software commands (listed in Sections 8-3 and 8-9), the Unidex 14 Control Board may be set to "Home" either to the CW or CCW switches. This "Homing" method provides the versatility of "Homing" speed adjustment as well as the ability to send an individual axis to home without effecting the position of the other axis.

The second method of "Homing" utilizes the Hardware Home logic of the individual Driver Modules. (See Chapter 6) This is the preferred method of "Homing" since the home position is referenced to the Index or Marker power of an encoder or similar device

NOTE: The Hardware Home feature utilizes Input 5 and Output 13 of the J2-I/O connector as control signals to the Unidex 14 Control Board. Thus, if Hardware Homing is selected, pins 5 and 13 of the J2 connector cannot be used as general purpose I/O (See Chapter 6 for more information.)

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SECTION 4-3 AUXILIARY CONTROL CONNECTIONS

4-3-1: CONNECTOR SPECIFICATIONS

For U14S, U14R, and U14H Chassis:

J10, J11, J17 and J18 for DSL and DAV Modules (DC Brush and Aerodrive Modules)

The auxiliary control connections for the U14S, U14R and U14H chassis are associated with connectors J10, J11, J17 and J18 for the X, Y, Z and T axes respectively. For DC Servo and Aerodrive operation the pin definitions for J10, J11, J17 and J18 are as follows: (See also Figures 4-1A, 4-1B and 4-2.)

Pin#	Description	Function
13	External clock (in) Max Frequency = 250KHz Min. Pulse Width = .5 m S	Remote input clock and direction control (Used if modules are enabled for remote mode, see Section 4-4)
6	External Direction (in) Logic 1 = CW Motor rotation. Logic 0 = CW Motor rotation.	
14	CWFB (out)	Buffered Encoder feedback output clock signal for external synchronization applications. Output pulse width per machine step = 1μSec (Not Opto-Isolated)
7	CCWFB (out)	
15	/Reset (out)	Axis reset status output (Driver low for "Loss of Encoder" and current trip).
8	/Marker (out)	Buffered Output Signal indicates state of Marker Input signal (See Section 4-2-2).
9	COS (in)	Encoder input signal. (Aerotech uses these inputs for linear encoder interfacing applications leaving limit connections on J13,J14,J19,J20 fully accessable to user.) (See Section 4-2-2)
2	/COS (in)	
10	SIN (in)	
3	/SIN (in)	
11	Marker (in)	
4	/Marker (in)	
12	+5VDC (200 mA max)	+ 5VDC for linear encoder use only.
5	Signal common	
1	Shield	

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4-3-2: CONNECTOR SPECIFICATIONS

U14S,U14R and U14H Chassis
J10,J11,J17 and J18 for D, DM and DMV Modules (Open Loop Stepping Modules)

The auxiliary control connections for the U14S, U14R and U14H Chassis assume different pin-out definitions when used with the low power Stepping Motor Drive Modules (D1401,D3001,DM1501,DM4001,DM4005,DM6006) or high power Stepping Motor Drive Modules (DMV8008,DMV16008) in the open loop configuration without Encoders. The pin definitions for these connectors when using the D,DM or DMV Series Stepping Modules are as follows:

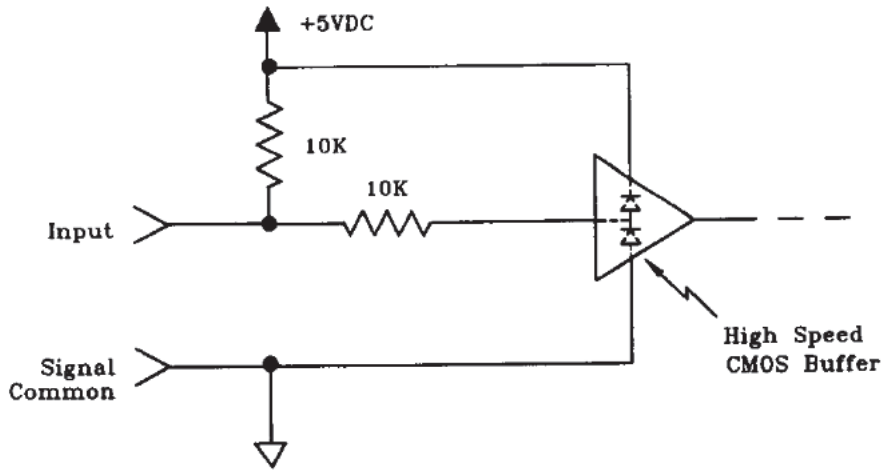
D, DM or DMV Series-J10,J11,J17 & 18 (U14S,U14R and U14H Chassis)

Pin#	Description	Function
13	External clock (in), Max Frequency = 250KHz. Min. Pulse Width = .5μS	Remote Input Clock and direction control (used if modules are enabled for Remote mode, see Section 4-4)
6	External direction (in) Logic 1 = CW Motor Rotation Logic 0 = CCW Motor Rotation	
2-4,7-12,14,15		(Connection for Aerotech use only)
5	Signal common	
1	Shield	

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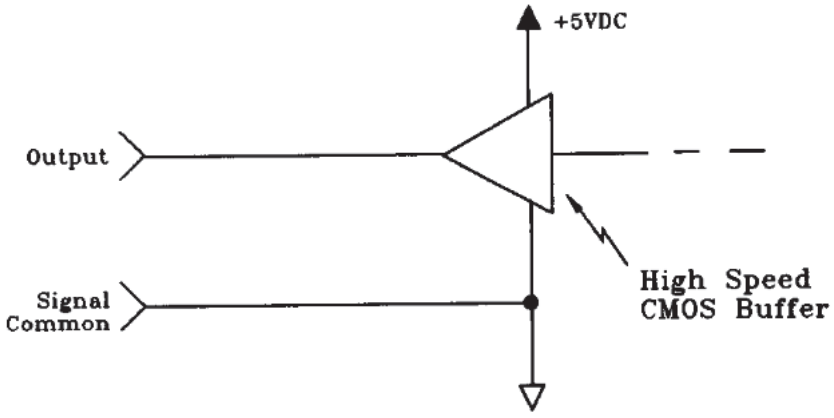
4-3-3: AUXILIARY CONTROL ELECTRICAL SPECIFICATIONS

The circuit configuration below illustrates input buffering for pins 13 and 6 described in Sections 4-3-1 and 4-3-2, and buffering for pins 12, 13, 22, 23, 24 and 25 of Section 4-2-2-1.



These inputs are protected against accidental overvoltage of ±30 volts. These inputs will accept dry contact, open collector, TTL and 5 to 15 volts CMOS.

The circuit configuration below illustrates output buffering for pins 14, 7, 15 and 8 described in Section 4-3-1.



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The specifications for these outputs are as follows:

Maximum current sourcing	+20mA
Maximum current sinking	- 20mA
Unloaded logic levels	+ 5 VDC logic high 0 VDC logic low
Loaded logic levels (@ ±5 mA sourcing or sinking)	+4.8 VDC logic high + .18 VDC logic low

SECTION 4-4: OPTO ISOLATED I/O INTERFACE CONNECTOR

Logic level input/output (I/O is provided through pin connections on connector J2 (J2 may be labeled "RS-232". Ignore this label, refer to Figures 4-1A and 4-1B).

An outline of J2 is shown in Figure 4-2.

All input/output logic connections on J2 are opto-isolated. It is important to note that some of these input and output connections have auxiliary (dual purpose) uses.

A pin description of pin connections for J2 is shown in Section 4-4-1.

A diagram of the input/output connector is shown in figure 4-2. The source current for all opto-coupler inputs requires 7mA of current minimum. The output opto-couples are capable of 10mA sinking at 20 VDC.

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4-4-1: J2 (I/O) CONNECTOR SPECIFICATIONS FOR THE U14S, U14R AND U14H CHASSIS

The J2 (I/O) connector pin descriptions are as follows:

Pin#	Main Function	Alternative (Consult Factory)
2,14	Input Opto-Coupler Anodes	None
15	Input 0	None
3	Input 1	None
16	Input 2	None
4	Input 3	None
17	Input 4	None
5	No Function	Input 5
18	Input 6 (Stepping Drives with or without 1MR Board)	None
	No Function (DC Brush Servo or Aerodrive Servo)	Input 6
6	Input 7 (Stepping Drives without 1MR Board only)	None
	No Function (Stepping Drives with 1MR Board,DC Brush Servo, Aerodrive Servo)	Input 7
20	Output 8	None
8	Output 9	None
21	Output 10	None
9	Output 11	None
22	No Function	Output 12
10	No Function	Output 13

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Pin#	Main Function	Alternative
7, 11, 19, 23	Output Opto-Coupler Emitters	None
24	Aux. X Output (Stepping Drives with 1MR Board,DC Brush Servo, Aerodrive Servo)	None
	No Function (Stepping Drives without 1MR Board only)	Aux. X Output
12	Aux. Y Output (Stepping Drives with 1MR Board,DC Brush Servo, Aerodrive Servo)	None
	No Function (Stepping Drives without 1MR Board only)	Aux. Y Output
25	Aux. Z Output (Stepping Drives with 1MR Board,DC Brush Servo, Aerodrive Servo)	None
	No Function (Stepping Drives without 1MR Board only)	Aux. Z Output
13	Aux. T Output (Stepping Drives with 1MR Board,DC Brush Servo, Aerodrive Servo)	None
	No Function (Stepping Drives without 1MR Board only)	Aux. T Output

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SECTION 4-5: SERIAL OUTPUT (SEO) INTERFACE

The Serial Output Interface (SEO) provides opto isolated (standard) or TTL/CMOS (optional) position information for external use (such as position counters/displays and speed indicators). Each SEO board (Figure 4-3) provides outputs for two axes, so two SEO boards are required for three or four axis applications. Outputs are present on the chassis rear panel at connectors J22 (X and Y axis) and J23 (Z and T axis). See Figures 4-1A, 4-1B and 4-2 for an outline of these connectors.

The outputs present at J22 and J23 vary for Stepping Motor Drives (D,DM and DMV Series) as opposed to DC Servo and Aerodrive Motor Drives (DSL and DAV Series). In addition, certain output variations and polarity inversions are possible within each subdivision. For J22/J23 outputs when DC Servo and Aerodrive Motor Drives are being used, see Table 4-3. For J22/J23 outputs when Stepping Drives are being used, see Table 4-2. Note that each table indicates the standard output functions, as well as applicable jumper information needed to change to certain optional output functions. Figure 4-6 shows the typical circuit for each available output. (These circuits are per axes)

The output signals for Stepping Motor Drives are Clock, Direction and /Marker or /Reset. (Note that a slash (/) indicates active low outputs, and no slash indicates active high.) The output signals for DC Servo and Aerodrive Motor Drives are CW Clock, CCW Clock and /Marker or /Reset. The /Marker signal is standard for both types of drives and the /Reset signal is optional. The following is a brief definition of each output.

1. Clock - This output is a mirror of the axis command clock. Each pulse represents one commanded step. (Stepping Drive only)

2. Direction - This output is a mirror of the axis command direction. Logic high (+5VDC) indicates CW motor rotation, logic low (0VDC) indicates CCW motor rotation. (Stepping Drive only)

3. /Marker (standard) - This output mirrors the system feedback reference pulse.

4. /Reset (optional) - This output indicates axis "reset" status.

5. CW Clock - This output is a 1μSec pulse that is derived from the Encoder Feedback signal when the servo motor is rotating in the CW direction. Each pulse represents one commanded machine step. (DC and Aerodrive only)

6. CCW Clock - Same as CW Clock except that it is produced by opposite direction motor rotation. (DC and Aerodrive only)

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NOTE: All cables interfacing to the SEO outputs should be limited in length to 15 ft. If longer cables are required, please consult factory for SEO modifications.

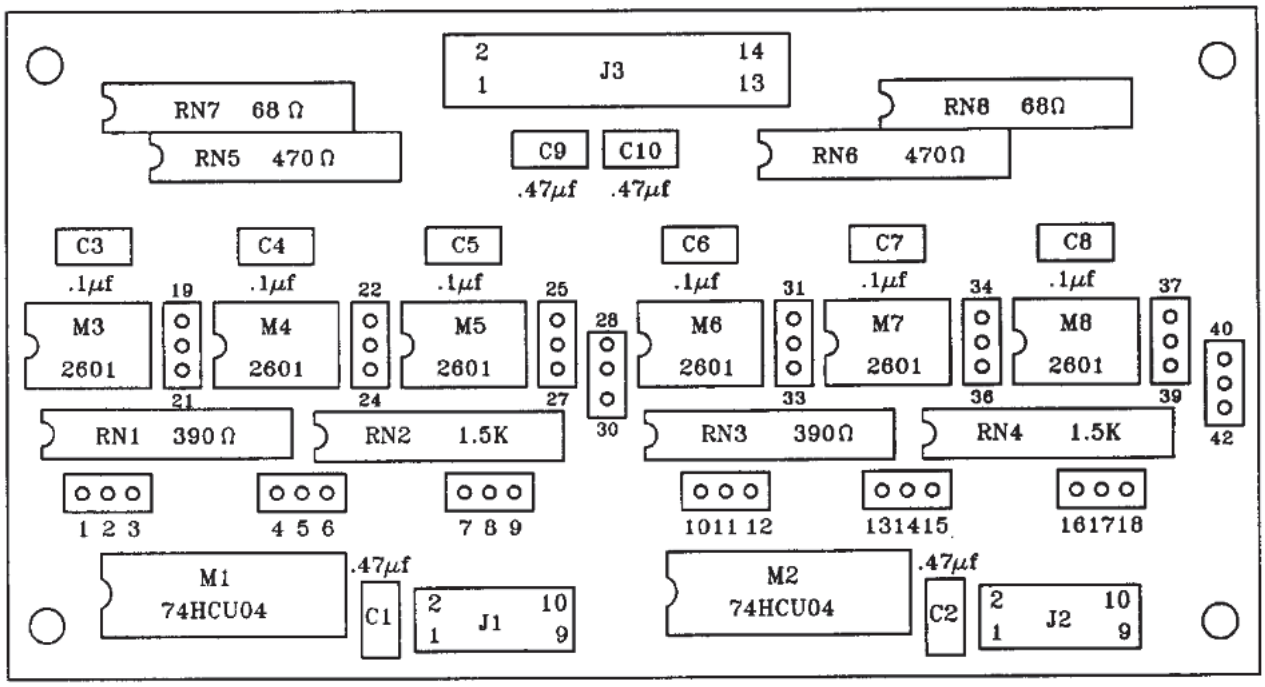
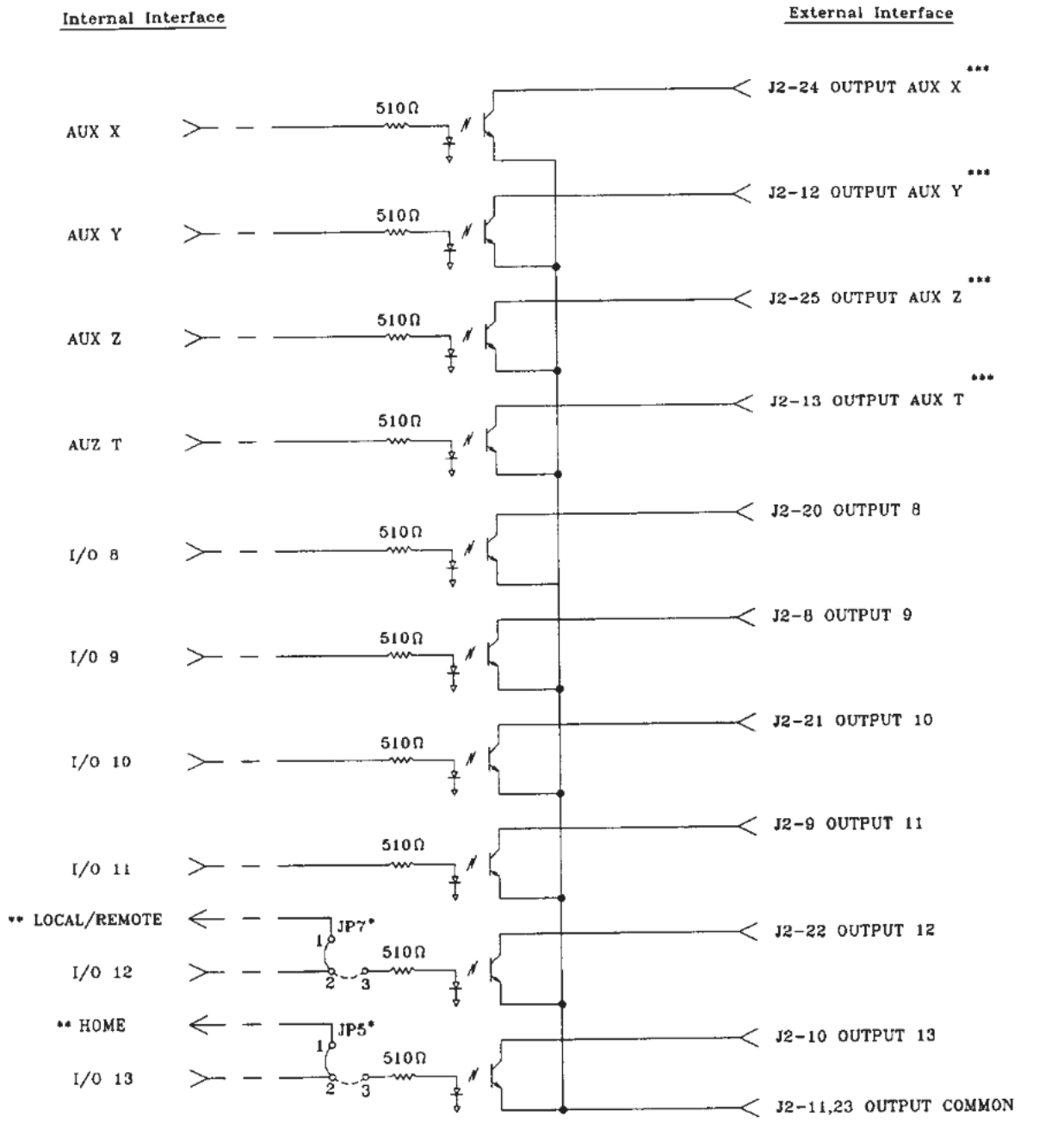


Figure 4-3: SEO Interface Board 690C1353

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* Alternative Functions

** Refer to Chapter 6 for jumper locations

*** Not available on any axis having a stepping motor that is assigned for Lo/Hi current control.

Figure 4-4: External Output Connections

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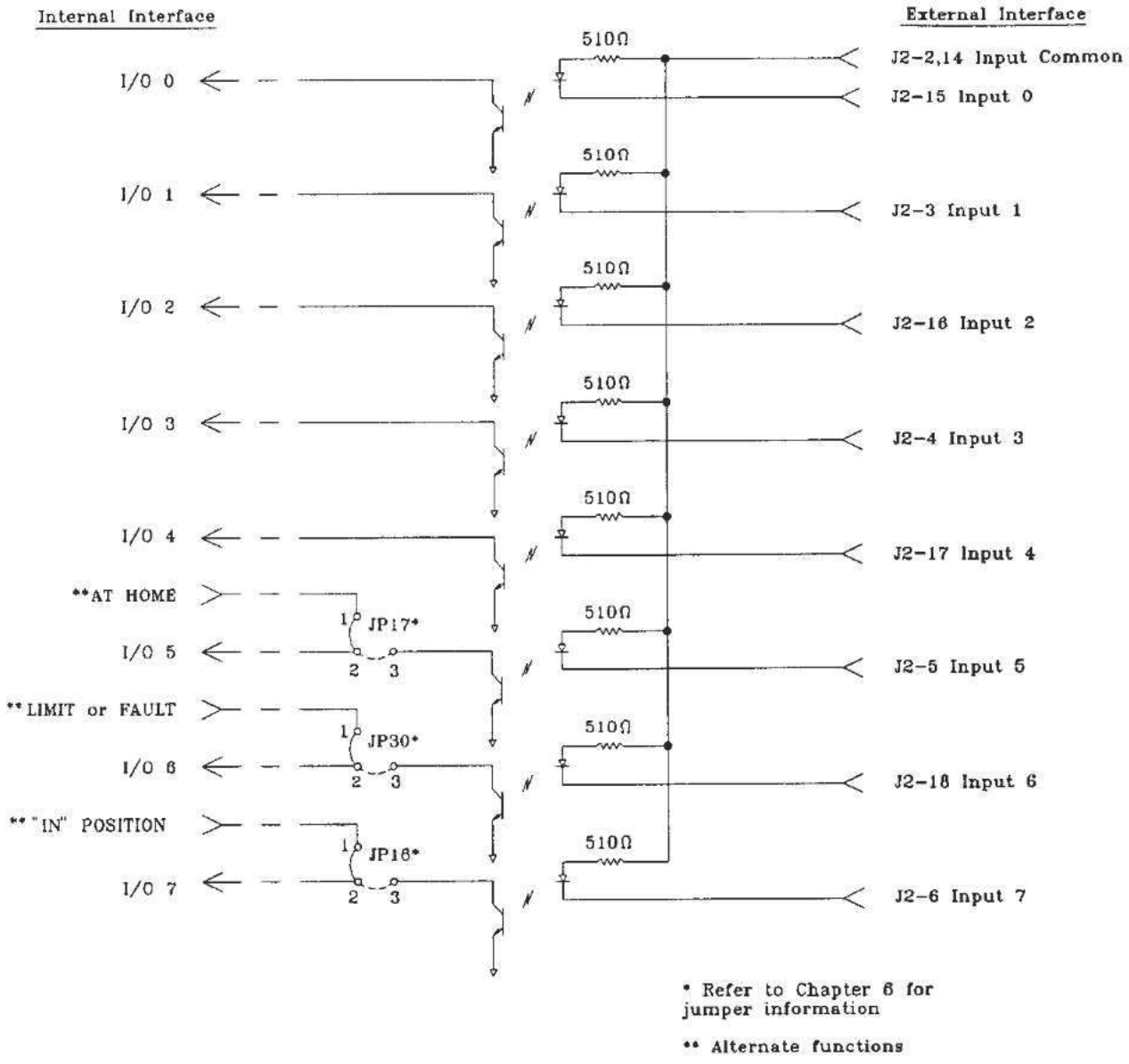


Figure 4-5: External Input Connections

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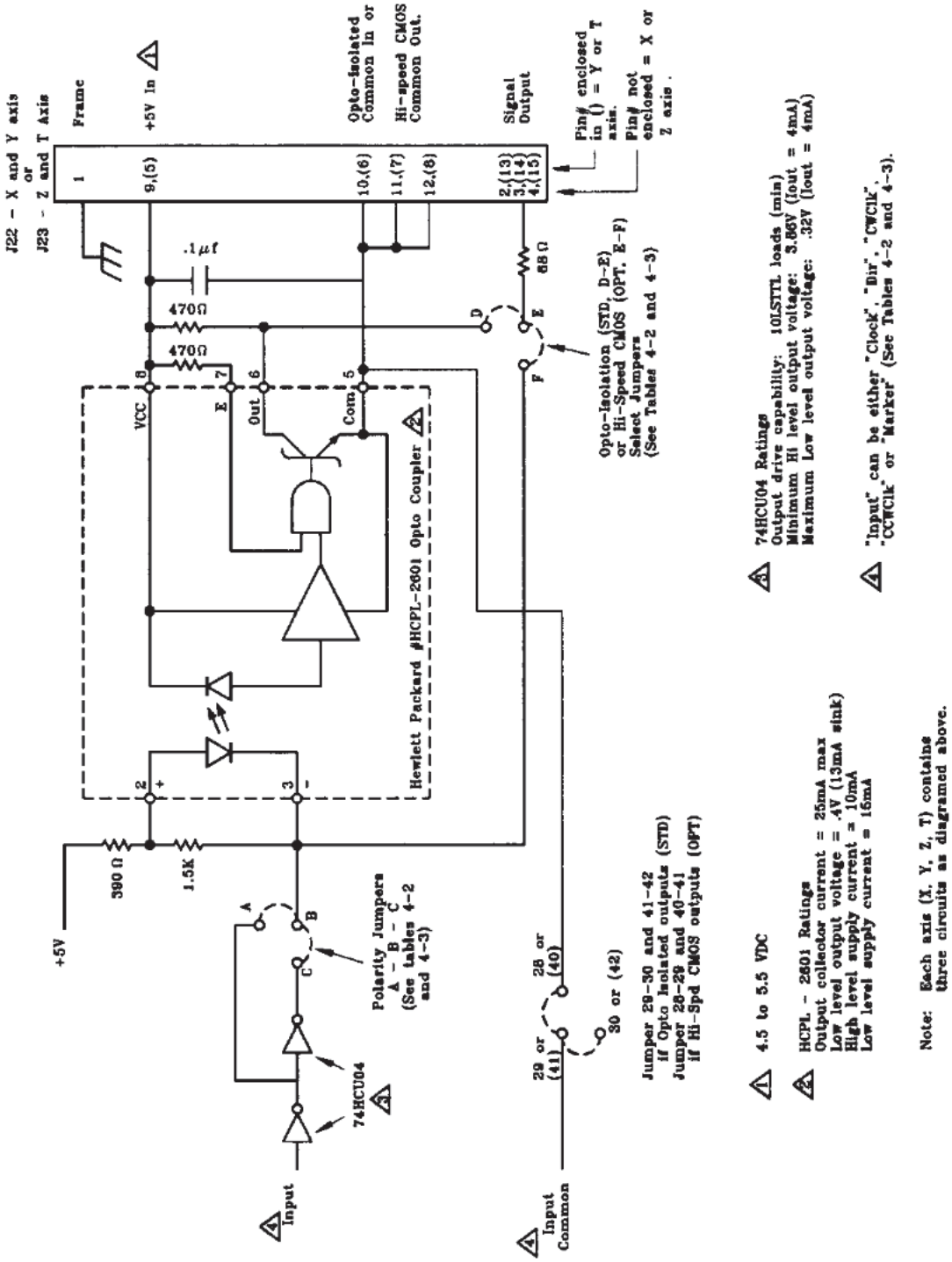


Figure 4-6: Typical "SEO" Output Circuit

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J22-X,Y (J23-Z,T) Pin #	Standard Input Function for given axis	Standard Input Function, Polarity Jumper A - B - C	Optional Input Function for given axis	Optional Input Function, Polarity Jumper A - B - C	Opto Isolation Output Select (STD) Jumper ⚠2 D - E - F	Hi-Speed C-MOS Output Select (Optional) ⚠3 Jumper D - E - F
1	Shield	_____	Shield	_____	_____	_____
9	X(Z)+5VDC In	_____	X(Z)+5VDC In	_____	_____	_____
10,11,12	X(Z) Com	_____	X(Z) Com	_____	_____	_____
2	X(Z) Clock	1-2-3	X(Z) /Clock	1-2-3	19-20-21	19-20-21
3	X(Z) Dir	4-5-6	X(Z) /Dir	4-5-6	22-23-24	22-23-24
4	X(Z)/Marker or ⚠4	7-8-9	X(Z) Marker or ⚠4	7-8-9	25-26-27	25-26-27
5	X(Z)/Reset	7-8-9	X(Z) Reset	7-8-9	25-26-27	25-26-27
6,7,8	Y(T)+5VDC In	_____	Y(T)+5VDC In	_____	_____	_____
13	Y(T) Com	_____	Y(T) Com	_____	_____	_____
14	Y(T) Clock	10-11-12	Y(T) /Clock	10-11-12	31-32-33	31-32-33
15	Y(T) Dir	13-14-15	Y(T) /Dir	13-14-15	34-35-36	34-35-36
	Y(T)/Marker or ⚠4	16-17-18	Y(T) Marker or ⚠4	16-17-18	37-38-39	37-38-39
	Y(T)/Reset	16-17-18	Y(T) Reset	16-17-18	37-38-39	37-38-39

NOTES:
1 /Output = Active low (0V), Output = Active high (+5VDC).
⚠2 If opto isolators are used, add jumpers 29-30, 41-42. See Figure 4-4.
⚠3 If hi-speed CMOS, add jumpers 28-29, 40-41. See Figure 4-4.
⚠4 A third input (per axis) can be "/Marker" or "/Reset". This is not field changeable. Input must be configured at factory. "/Marker" input is standard unless specified otherwise.

Table 4-2: Stepping Motor Drive-J22, J23 Standard and Optional Input Configuration Definitions and Options

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J22-X,Y (J23-Z,T) Pin #	Standard Input Function for given axis	Standard Input Function, Polarity Jumper A - B - C	Optional Input Function for given axis	Optional Input Function, Polarity Jumper A - B - C	Opto Isolation Output Select (STD) Jumper 2 D - E - F	Hi-Speed C-MOS Output Select (Optional) 3 Jumper D - E - F
1	Shield	_____	Shield	_____	_____	_____
9	X(Z)+5VDC In	_____	X(Z)+5VDC In	_____	_____	_____
10,11,12	X(Z) Com	_____	X(Z) Com	_____	_____	_____
2	X(Z) CW CLK	1-2-3	X(Z) /CW CLK	1-2-3	19-20-21	19-20-21
3	X(Z) CCW CLK	4-5-6	X(Z)/CCW CLK	4-5-6	22-23-24	22-23-24
4	X(Z)/Marker or 4	7-8-9	X(Z) Marker or 4	7-8-9	25-26-27	25-26-27
5	X(Z)/Reset	7-8-9	X(Z) Reset	7-8-9	25-26-27	25-26-27
6,7,8	Y(T)+5VDC In	_____	Y(T)+5VDC In	_____	_____	_____
13	Y(T) Com	_____	Y(T) Com	_____	_____	_____
14	Y(T) CW CLK	10-11-12	Y(T) /CW CLK	10-11-12	31-32-33	31-32-33
15	Y(T)CCW CLK	13-14-15	Y(T)/CCW CLK	13-14-15	34-35-36	34-35-36
	Y(T)/Marker or 4	16-17-18	Y(T) Marker or 4	16-17-18	37-38-39	37-38-39
	Y(T)/Reset	16-17-18	Y(T) Reset	16-17-18	37-38-39	37-38-39

NOTES:
1 /Output = Active low (0V), Output = Active high (+5VDC).
2 If opto isolators are used, add jumpers 29-30, 41-42. See Figure 4-4.
3 If hi-speed CMOS, add jumpers 28-29, 40-41. See Figure 4-4.
4 A third input (per axis) can be "/Marker" or "/Reset". This is not field changeable. Input must be configured at factory. "/Marker" input is standard unless specified otherwise.

Table 4-3: DC Servo and Aerodrive - J22, J23 Standard and Optional Input Configuration Definitions and Options

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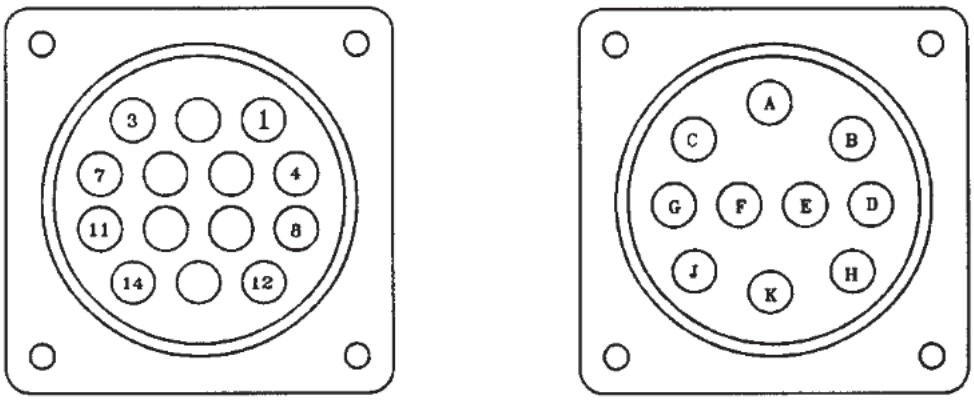
SECTION 4-6: UNIDEX 14 POWER CONNECTIONS

Input power to the Unidex 14 U14S, U14R and U14H chasses involves only a single 115 or 230VAC 50/60Hz input connection (see Figure 4-1A and 4-1B). (Figure 4-11 shows a detailed outline of this connection).

Motor output connections (up to four, depending on the type of chassis) consists of either Stepping Motor, Aerodrive or DC Servo Motor termination. Two types of motor output receptacles are available. An outline of these receptacles is shown in Figure 4-7.

Motor terminations to the receptacles shown in Figure 4-7 are of three types, two for Aerodrive and Stepping Motor operation, and one for DC Motor operation. Stepping Motor and Aerodrive termination can be of either "bipolar" wound or "unipolar" wound, as shown in Figures 4-8 and 4-9 respectively. DC Servo Motor termination is shown in Figure 4-10.

It should be noted that if the Unidex 14 is supplied with Aerotech motors and cables, you need not concern yourself with the detailed wiring termination shown in Figures 4-8, 4-9, 4-10 and 4-11.



14 Pin Plastic Style (Standard)

10 Pin Metal Style (Optional)

Figure 4-7: Motor Output Receptacles at Rear of U14S, U14R and U14H Chassis

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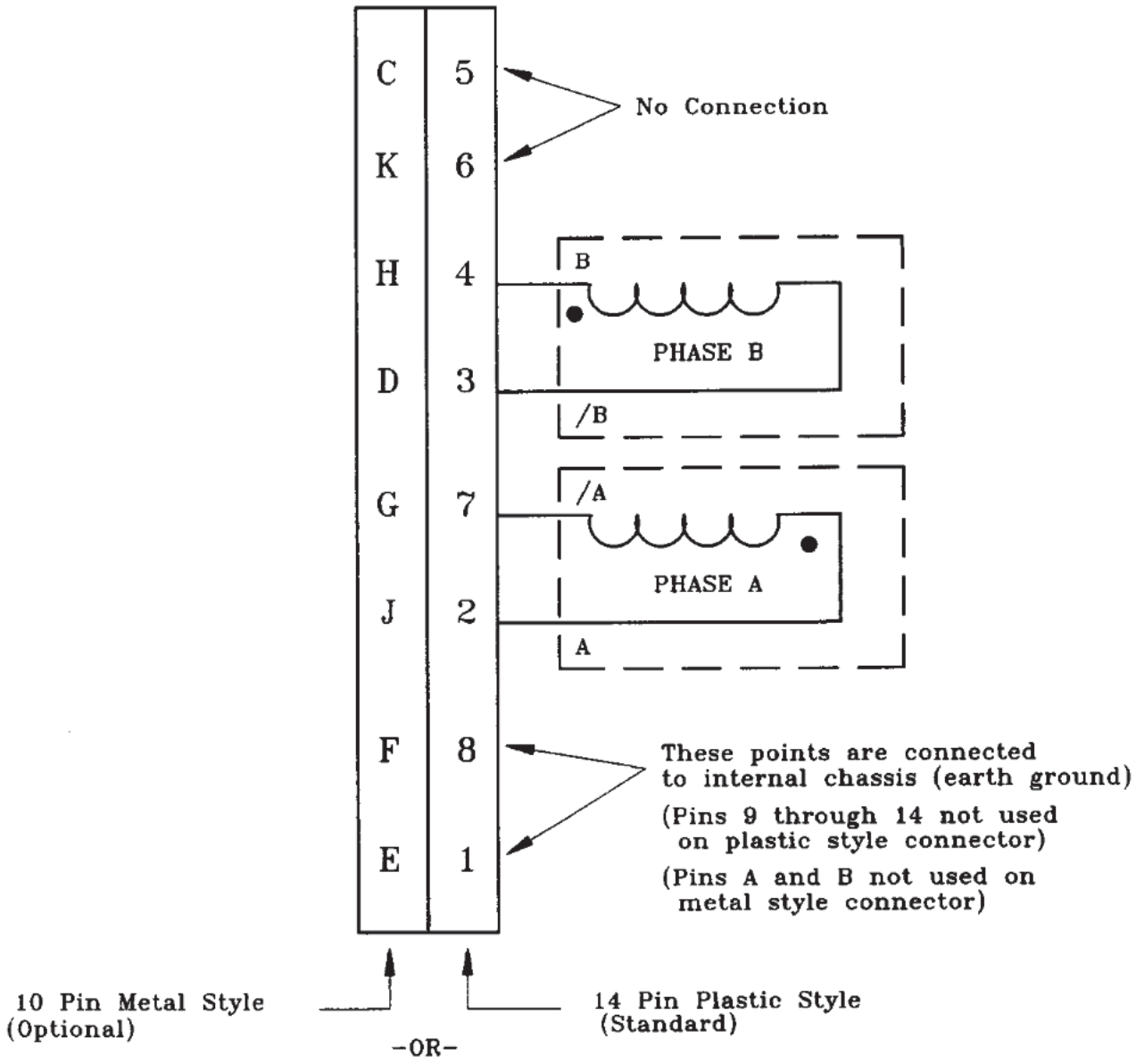


Figure 4-8: Outline of Connections for "Bipolar" Wound Stepping Motor and Aerodrive Motor

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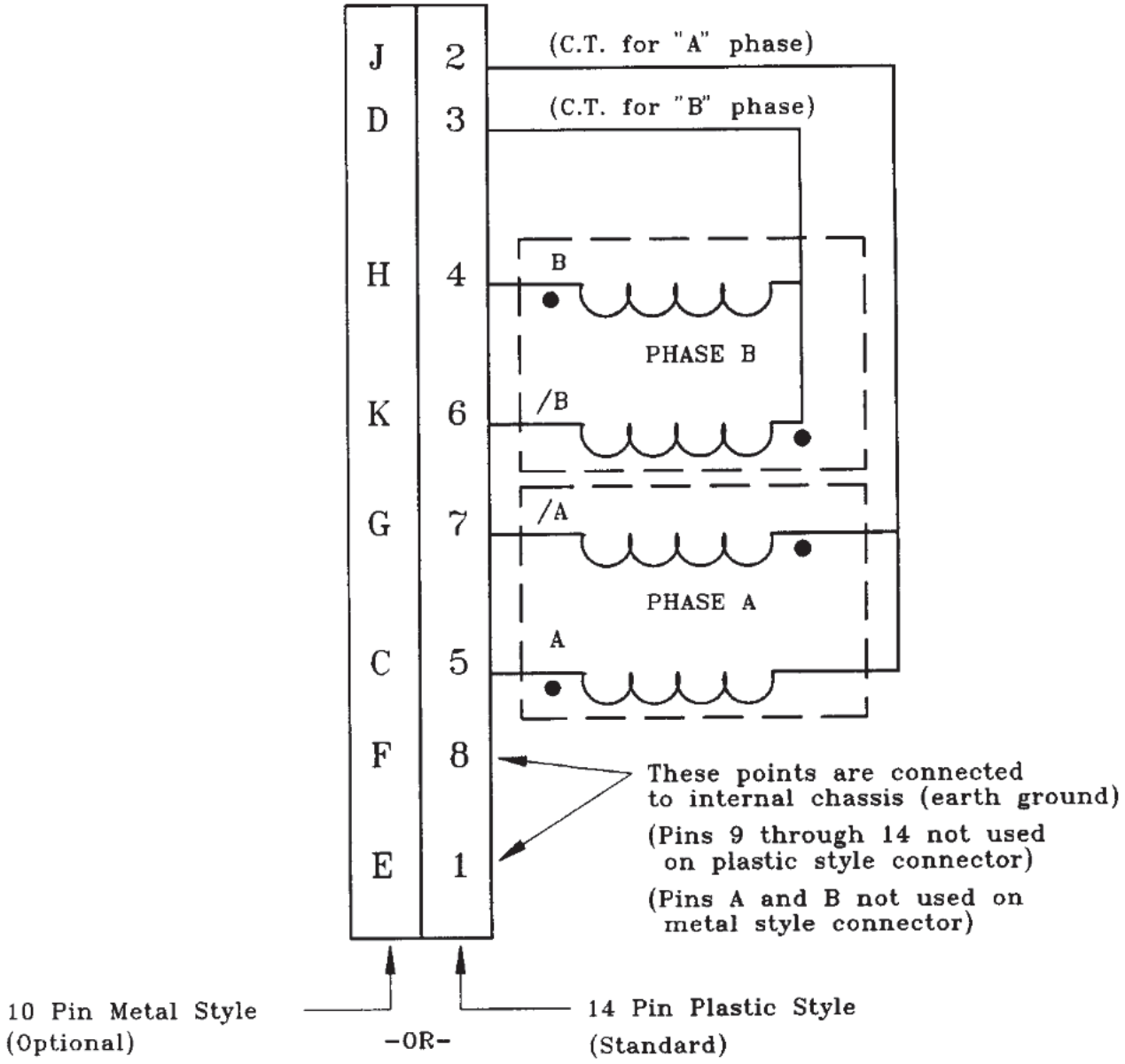


Figure 4-9: Outline of Connections for "Unipolar" Wound Stepping Motor and Aerodrive Motors

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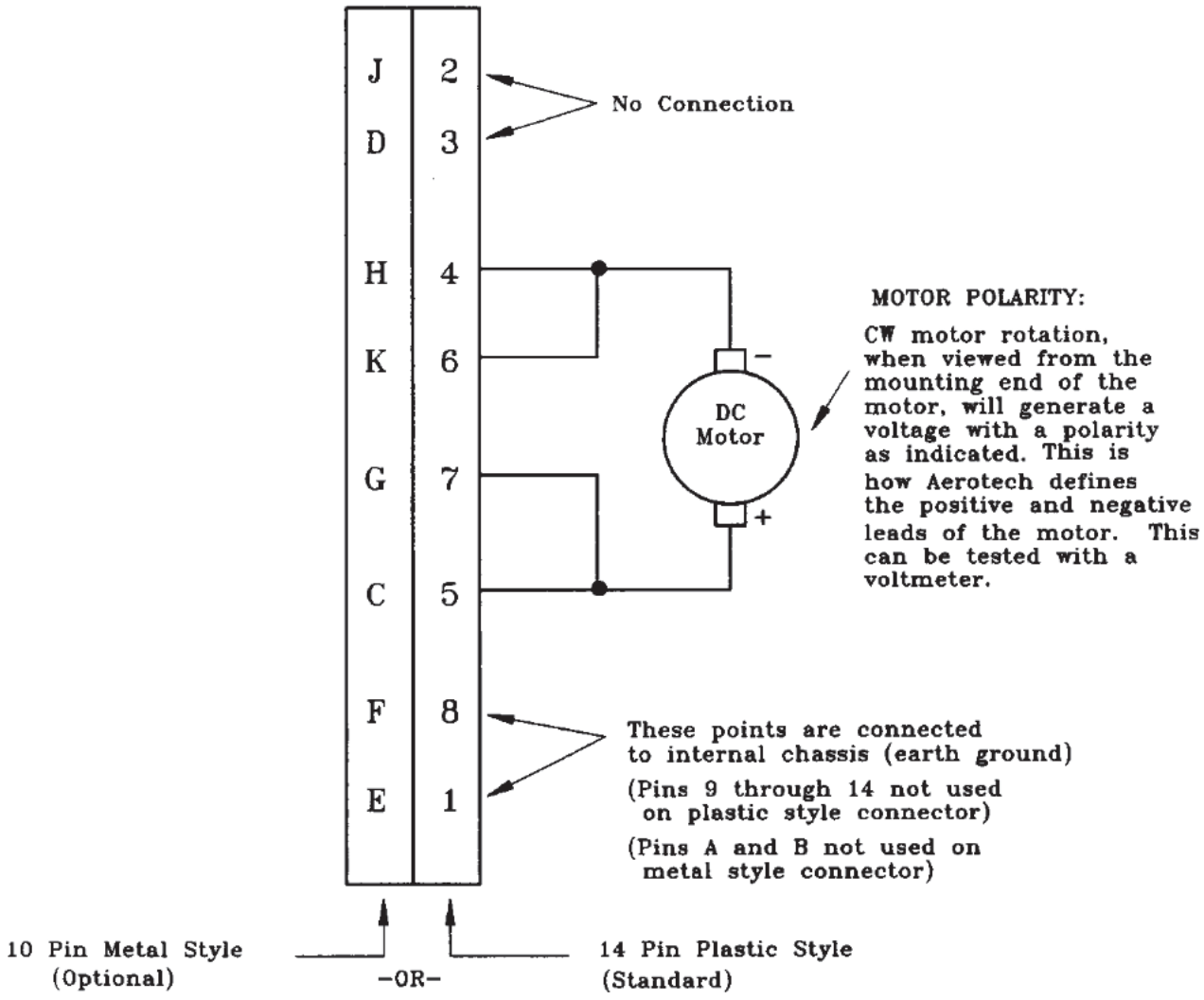


Figure 4-10: Outline of Connections for "Brush" Type DC Servo Motor

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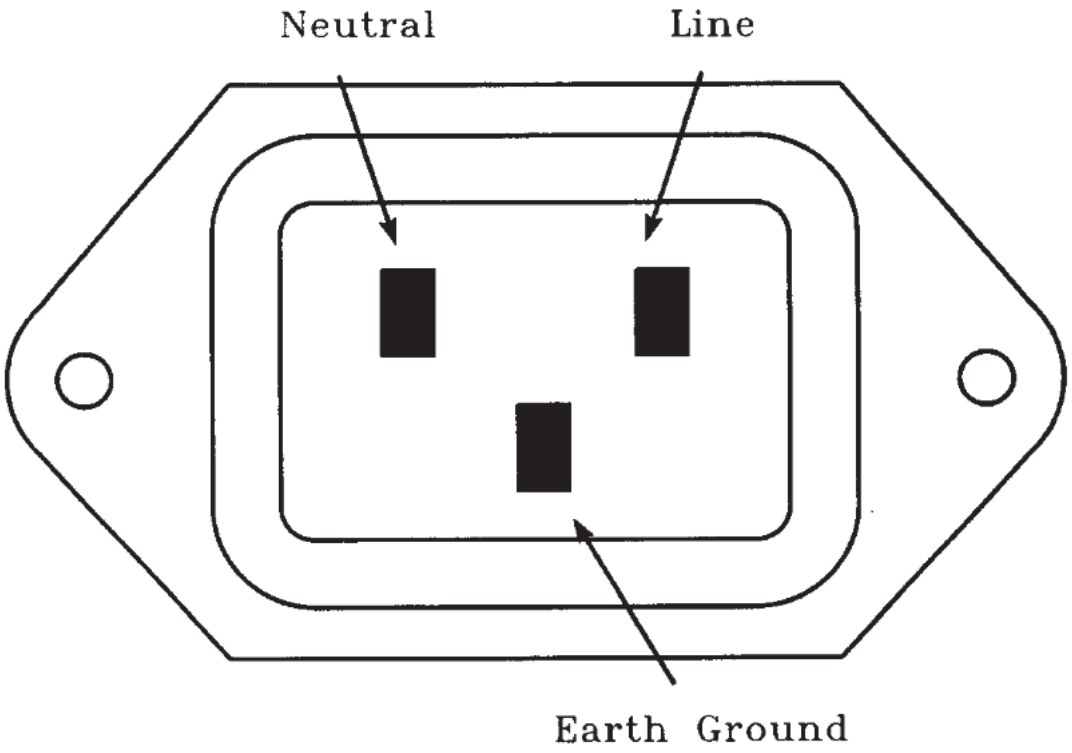


Figure 4-11: Outline of Input Power Receptacle at the Rear of Unidex 14 Chassis

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CHAPTER 5: INTERNAL STRUCTURE OF UNIDEX 14

SECTION 5-1: DESCRIPTION OF U14S, U14R AND U14H DRIVE CHASSIS'S:

This chapter briefly discusses the internal hardware and drive module organization of the Unidex 14 U14S, U14R and U14H Chassis. This section contains general information regarding the placement into a given Chassis of Aerodrive, Stepping and/or DC Servo Drive modules (described in Chapter 4 of this Manual). Information on powerinterconnect wiring for the Drive modules in the chassis is also provided. For detailed information on specific Drive Modules (ie., DM4005, DAV16008, DSL8020 ect.), the U14 Control Interface Board, and their Power Supply Board, See Chapter 6 of this Manual.

A simplified wiring diagram of the U14S and U14R is shown in Figure 5-1. An accompanying outline of these Chassis with the front panel removed is shown in Figure 5-2. Figures 5-3 and 5-4 show similar drawings for the U14H chassis.

The U14S, U14R and U14H chassis provide a DC bus power supply for high power Stepping motor operation (using the DMV8008 and DMV16008) DC Servo motor operation (using the DSL3015, DSL4020, DSL8020 and DSL16020), and Aerodrive Motor operation (using the DAV4008 and DAV16008). The low power Stepping Drive modules (D and DM Series) can be used in these chassis without the need for a DC bus power supply (i.e., these modules internally generate control and bus power for the motor).

The DC bus power supply for the U14S, U14R and U14H chassis (see Figure 5-1 and 5-3) can be configured for a variety of DC voltage levels for use with the DMV8008, DMV16008, DAV4008, DAV16008, DSL3015, DSL4020, DSL8020 and DSL16020 Drive modules. The possible DC bus voltage levels for a given chassis is as follows:

U14S AND U14R CHASSIS:

DC BUS VOLTAGE	AXIS DISTRIBUTION
20VDC	All axes; X,Y,Z; Y,Z,T; X,Y; Z,T axes
40VDC	All axes; X,Y,Z; Y,Z,T; X,Y; Z,T axes
60VDC	All axes only
80VDC	All axes only

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U14H CHASSIS:

DC BUS VOLTAGE	AXIS DISTRIBUTION
20VDC**	All axes, any single axis, or any axes group
40VDC**	All axes, any single axis, or any axes group
60VDC**	All axes, any single axis, or any axes group
80VDC**	All axes, any single axis, or any axes group
100VDC*	All axes only
120VDC*	All axes only
140VDC*	All axes only
160VDC*	All axes only

* **These voltages are applicable to DMV16008, DSL16020 and DAV16008 operation only. 160VDC operation can be derived "off-line" (US/Domestic 115VAC line) without the use of transformer T1 or T2.**

** **Some combinations are only possible with 2 transformers (1500W option, 2P11-xxx).**

The secondary side of transformer T1 (and T2) provides the necessary AC voltage to be rectified to DC (see figures 5-1 and 5-3).

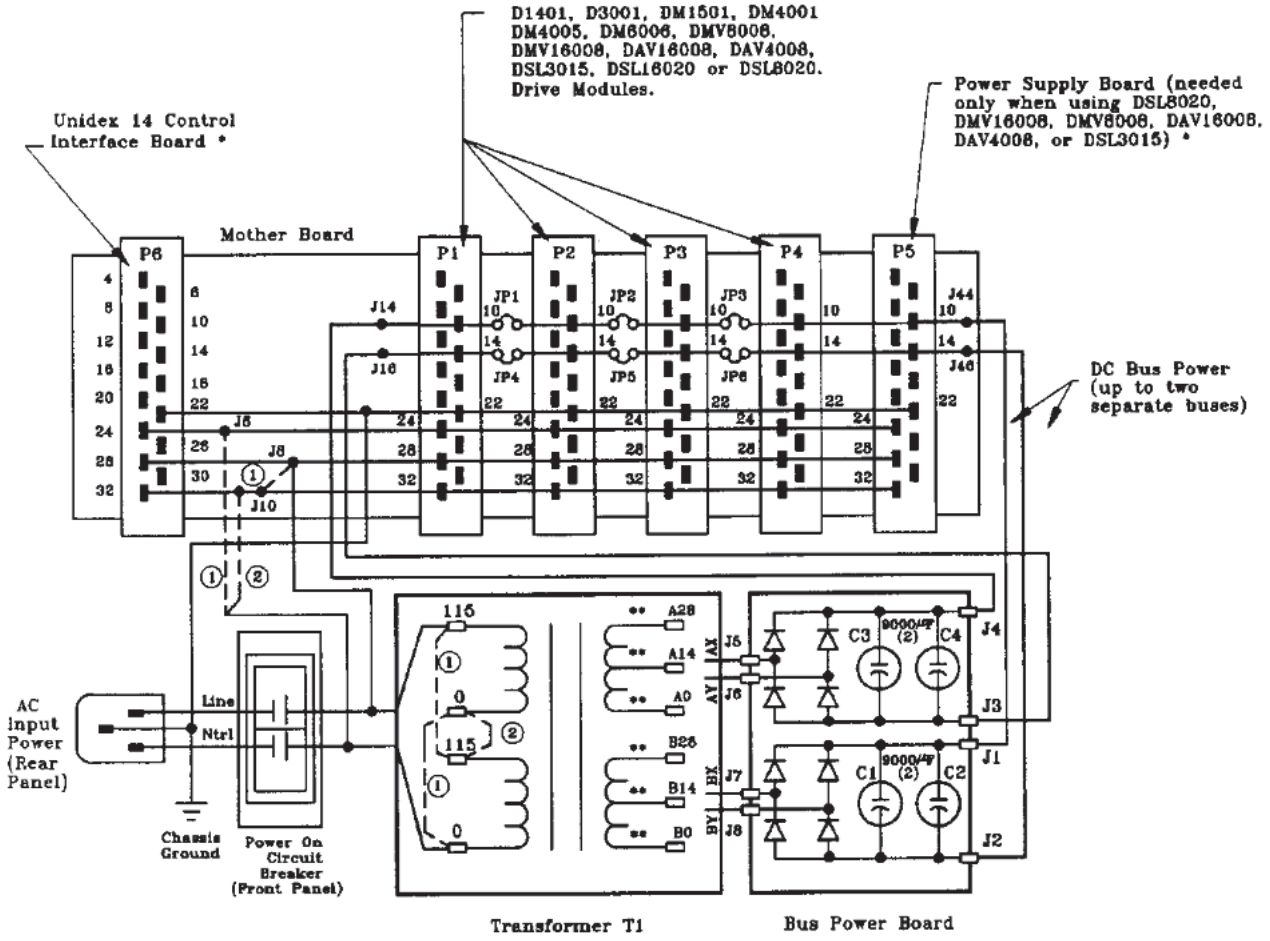
The individual transformer secondary windings A0-A14-A28, B0-B14-B28, etc., each supply up to 28VAC centertap voltages (A14, B14, etc. are the centertap connection).

Jumper connections on the motherboard (JP1, JP2, JP3, etc.) provide "connect/disconnect" points to the given axis for the selected DC bus voltages supplied by capacitors C1 through C4.

NOTE: DC Bus Power for the DSL3015 is handled differently than other drives. The DSL3015 as a "Class B" push-pull "Linear" amplifier requiring two DC Bus ("Plus" and "Minus"). The "Plus" bus is connected as shown in Figures 5-1 and 5-2. The "Minus" bus is connected to "Pin 4" of each drive slot (P1, P2, P3 and P4).

NOTE: The drive module slots (P1-P4, see Figures 5-1, 5-2, 5-3 and 5-4) are electrically interconnected so that damage will NOT occur to a given module or motor (if, for example, a stepping drive module is inadvertently plugged into a slot setup for DC servo operation). *Nevertheless, special care should be taken when removing the drive modules from the Unidex 14 chassis.*

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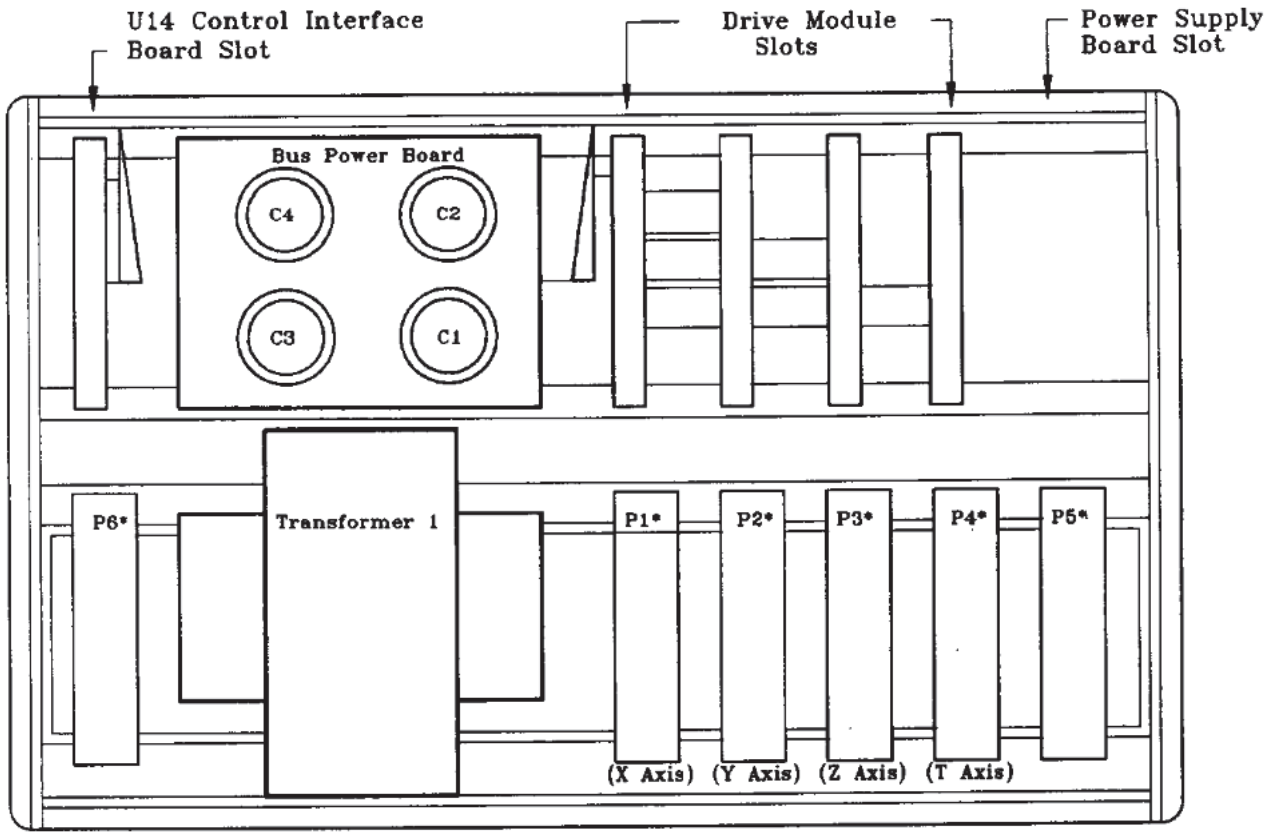
AC Input Power Configuration:
① – 115VAC Operation
② – 230VAC Operation

* For more information on power, control & drive modules, see Chapter 4 & Chapter 6.

** AC Power termination for DC Bus Power (applies to DSL8020, DAV4008, DAV16008, DMV8008, DMV16008, DSL16020 and DSL3015 only)

Figure 5-1: Simplified Wiring Diagram of U14S & U14R Chassis with Front Panel Removed (see Figure 5-2 for Outline)

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FRONT VIEW

Figure 5-2: Outline of the U14S and U14R Chassis with Front Panel Removed

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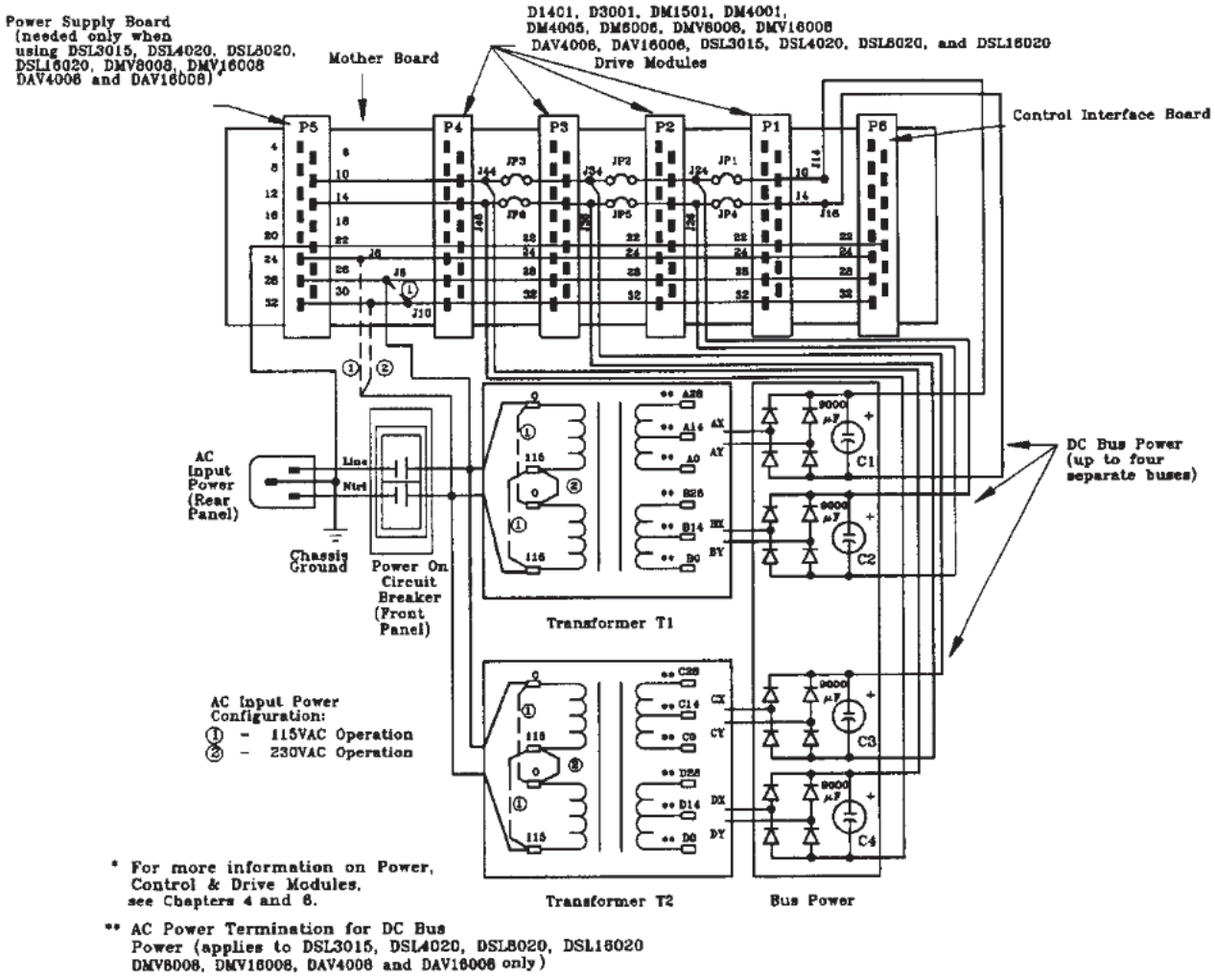


Figure 5-3: Simplified Wiring Diagram of U14H Chassis with Top Cover Removed (see Figure 5-4 for Outline)

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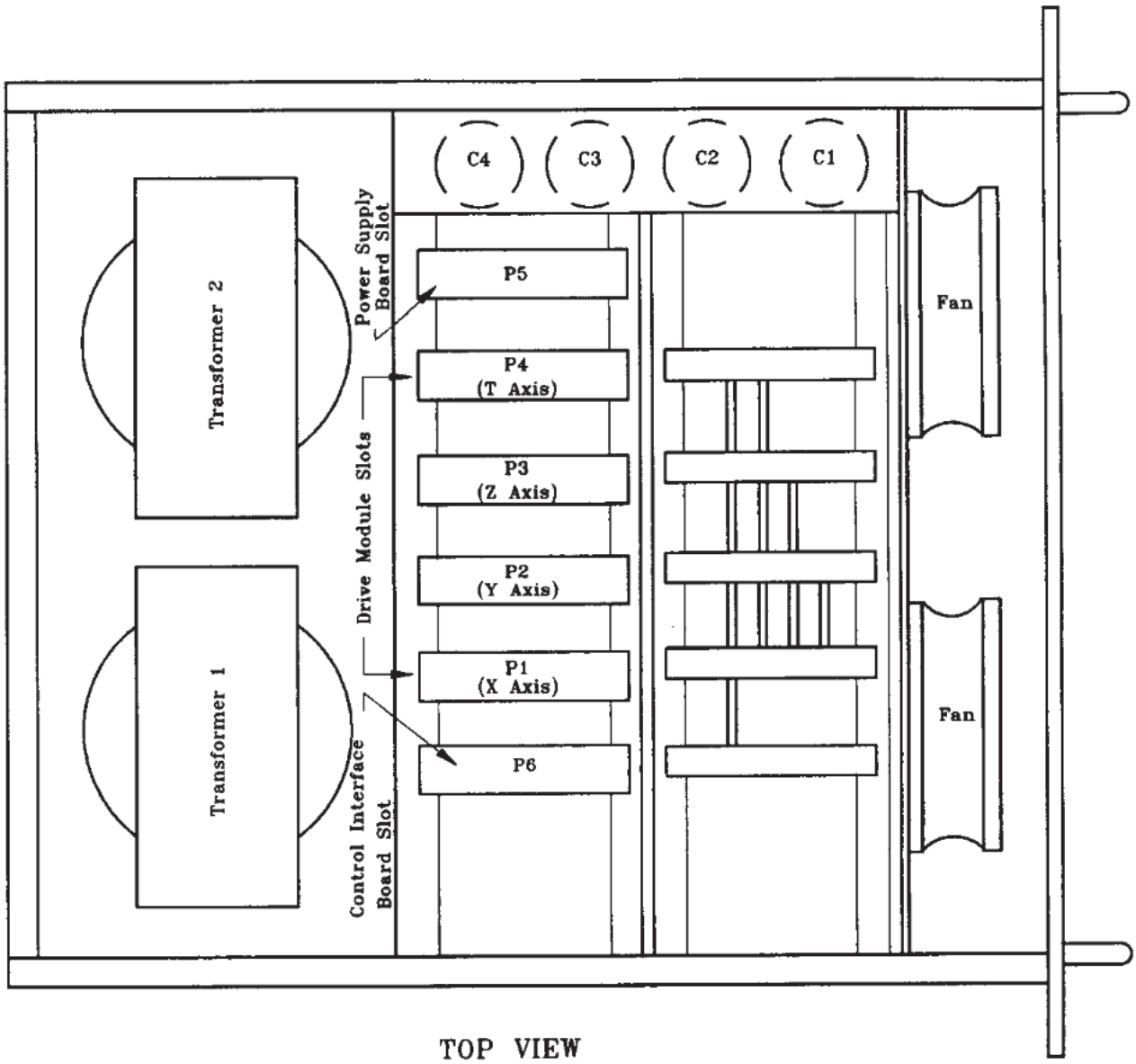


Figure 5-4: Outline of the U14H Chassis with Top Cover Removed

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SECTION 5-2: DESCRIPTION OF THE U14C CONTROL BOARD

A schematic of the U14C Control Board is shown in Figures 5-5 thru 5-23. A simplified block diagram of this board is shown in Figure 1-1, Jumper locations are shown in Figure 2-1.

Normally the user need not be concerned with the details of these schematics. However, the general description of the schematics which follow, may aid in understanding the Unidex 14 Control System.

The 68000 microprocessor on the U14C Control Board maintains four concurrent processes. The highest priority process calculates the desired pulse frequency 1024 times each second with a proprietary algorithm (patent number 4,734,847). This number is fed to U62, U63, U64 and U65 which synchronizes the motor pulses to the microprocessor and actually generate the pulse train. The velocity profile and synchronization of each axis is also handled by the 68000.

The commands from the PC/XT/AT or compatible host computer are temporarily stored in a 124 character buffer until the 68000 microprocessor can parse them. The command is then executed immediately or routed to separate command queues for each axis. The command queue contains a list of addresses to execute followed by an optional parameter. A command from the host may be expanded into several commands to the appropriate axis. The GO command for example will expand into start, ramp up, constant velocity and ramp down commands. The LS command will save its parameter, i.e. the loop count, on a loop stack along with the address of the LS command to used by the next LE command as a target for a jump command. The LE command will decrement the loop count and jump to the most recent LS command providing the loop count has not reached zero. If the loop count has reached zero and it is not nested inside another loop, the queue space will be flagged as available and the next instruction in the queue will be executed.

Interrupts to the PC/XT/AT host are latched by U33. The enable status of each interrupt is also stored by U33. Status of the interrupts and error flags may be read by the host via U33. U12 latches the interrupt request enable bits and allows them to be read back by the microprocessor. U16 compares the address to the I/O address selected by the host and enables the board decode logic when a match is detected.

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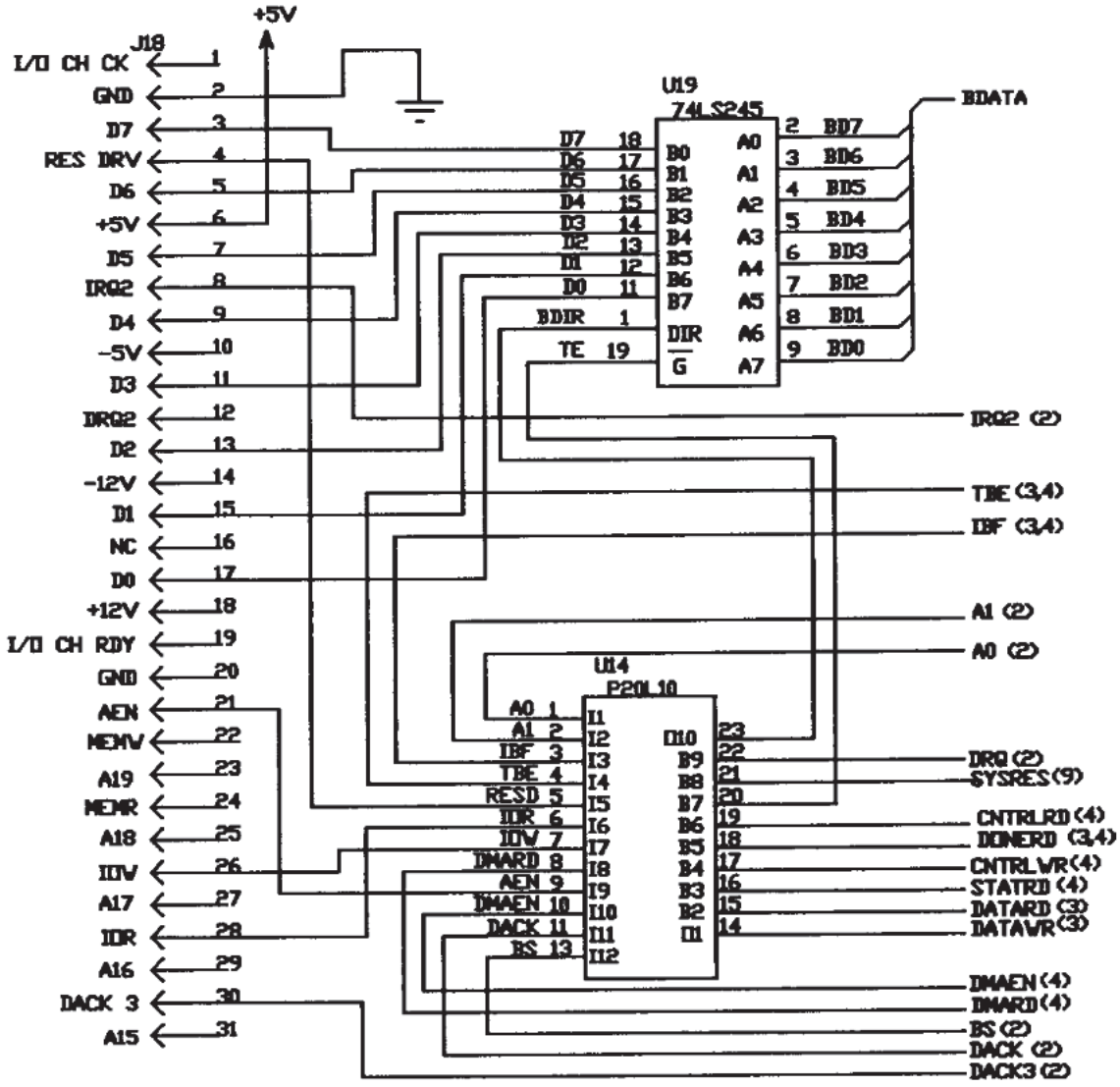


Figure 5-5: U14C Control Board Schematic

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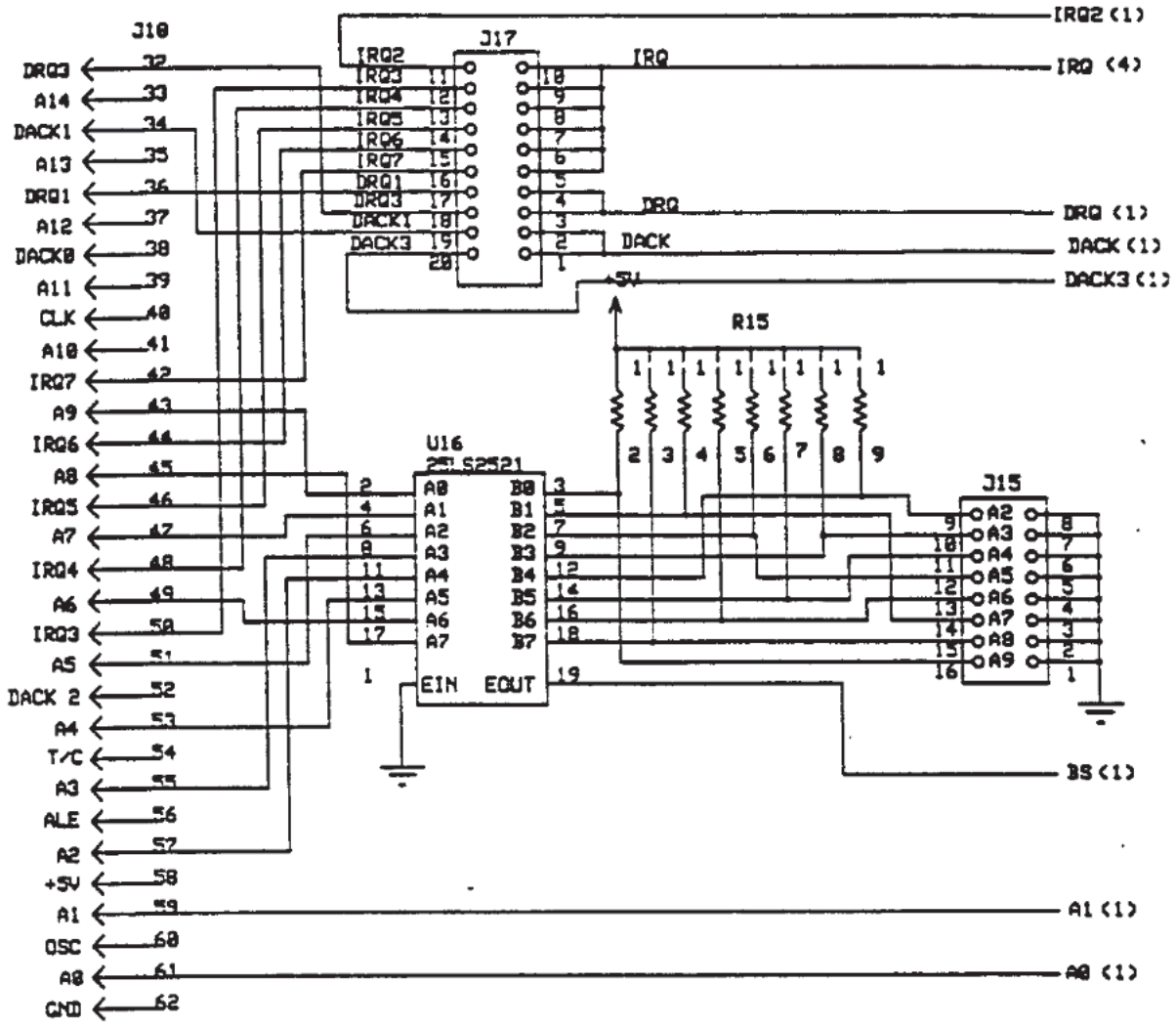


Figure 5-6: U14C Control Board Schematic (con't)

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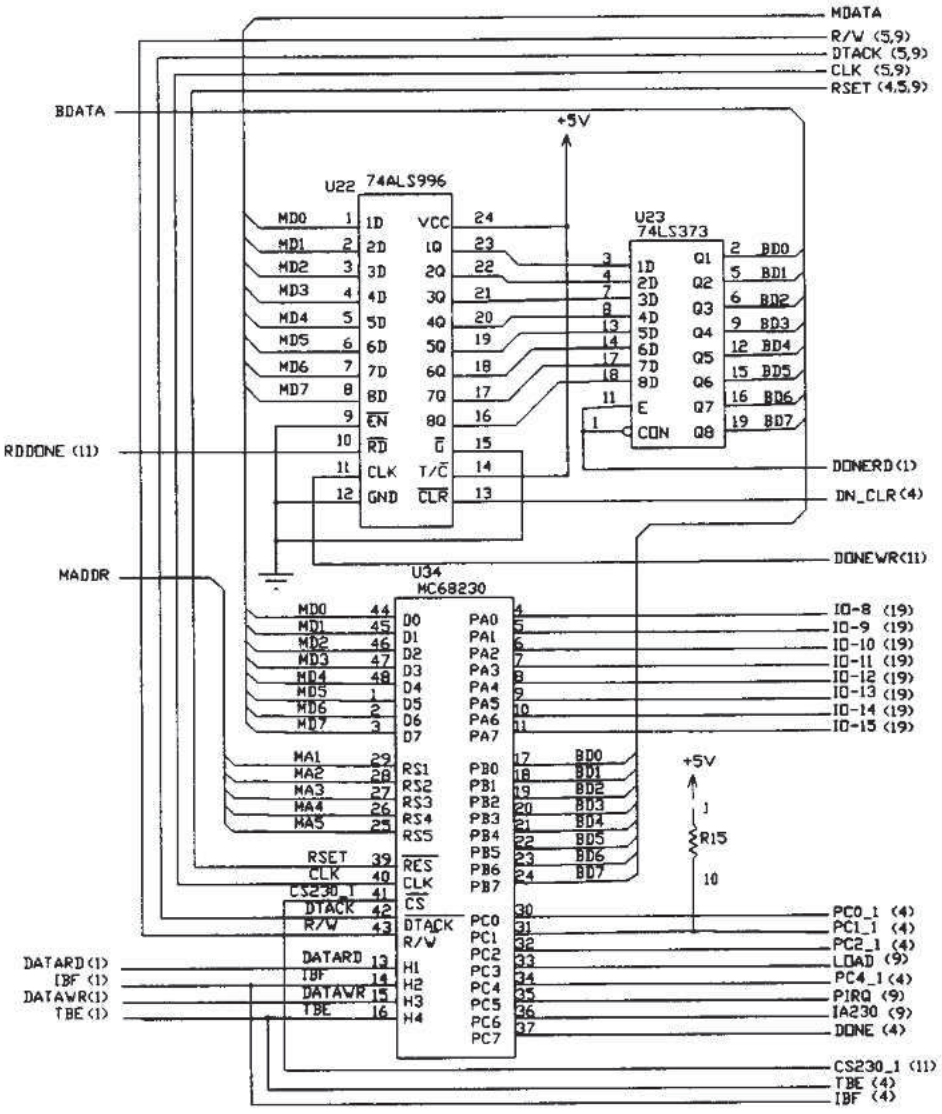


Figure 5-7: U14C Control Board Schematic (con't)

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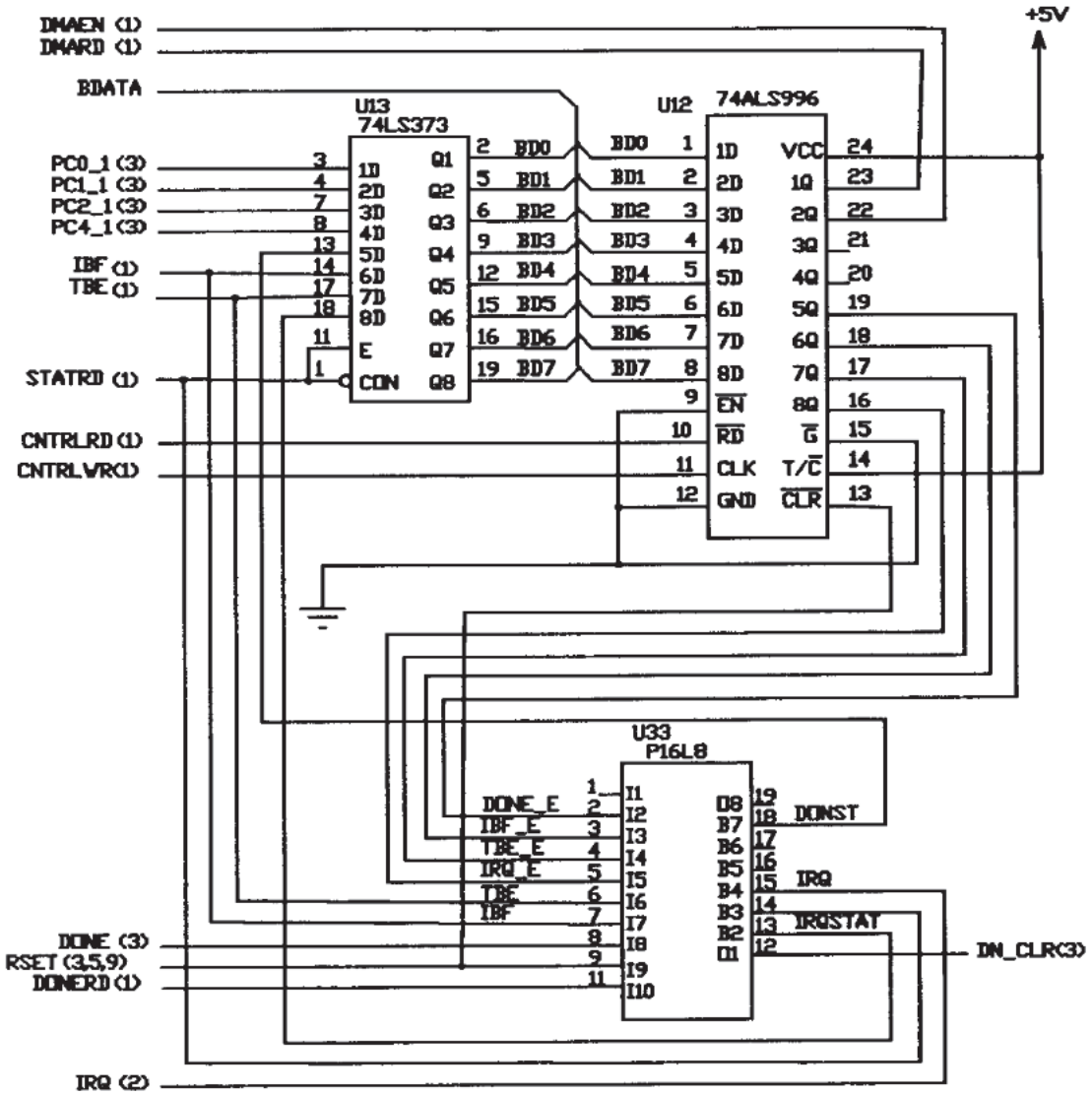


Figure 5-8: U14C Control Board Schematic (con't)

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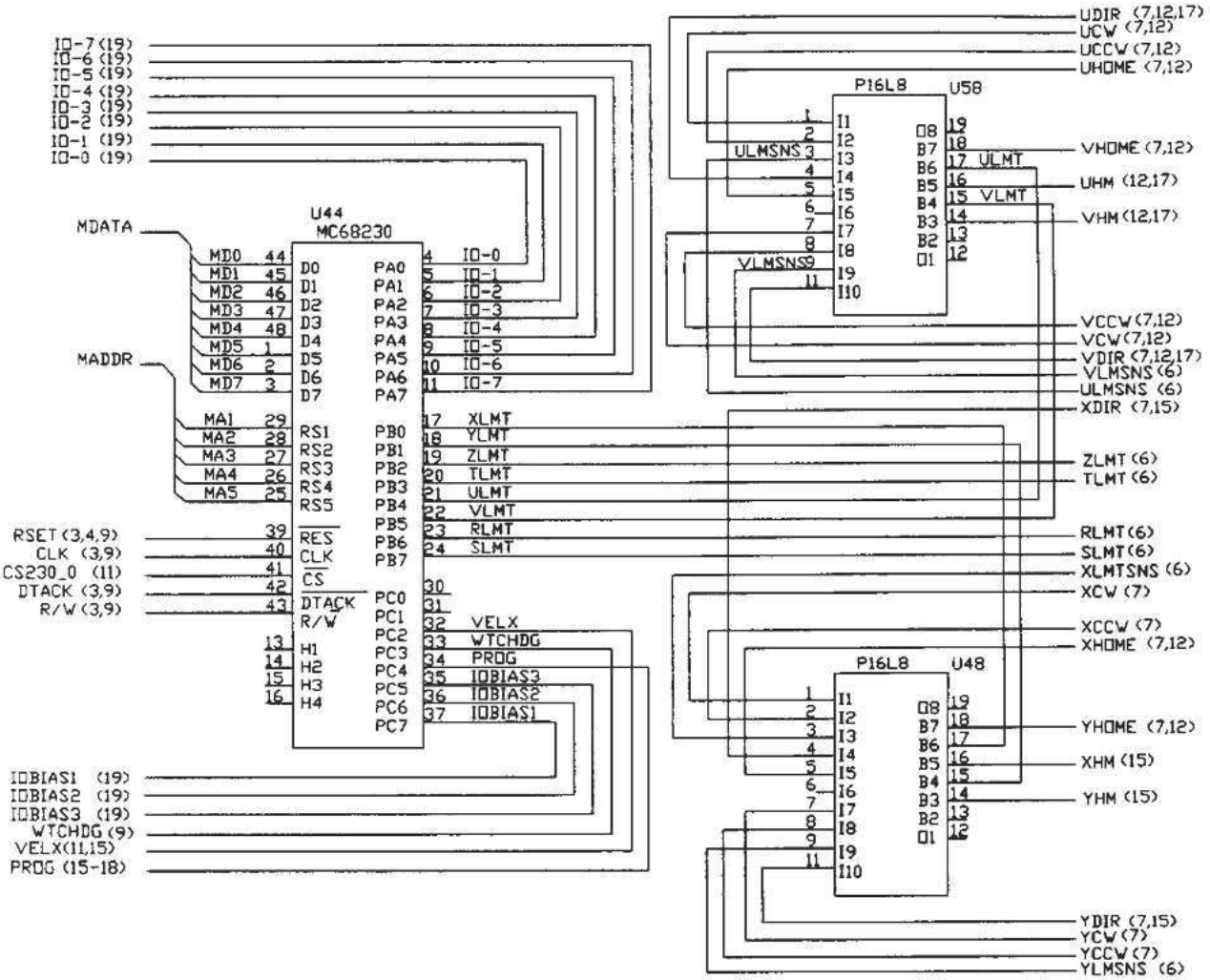


Figure 5-9: U14C Control Board Schematic (con't)

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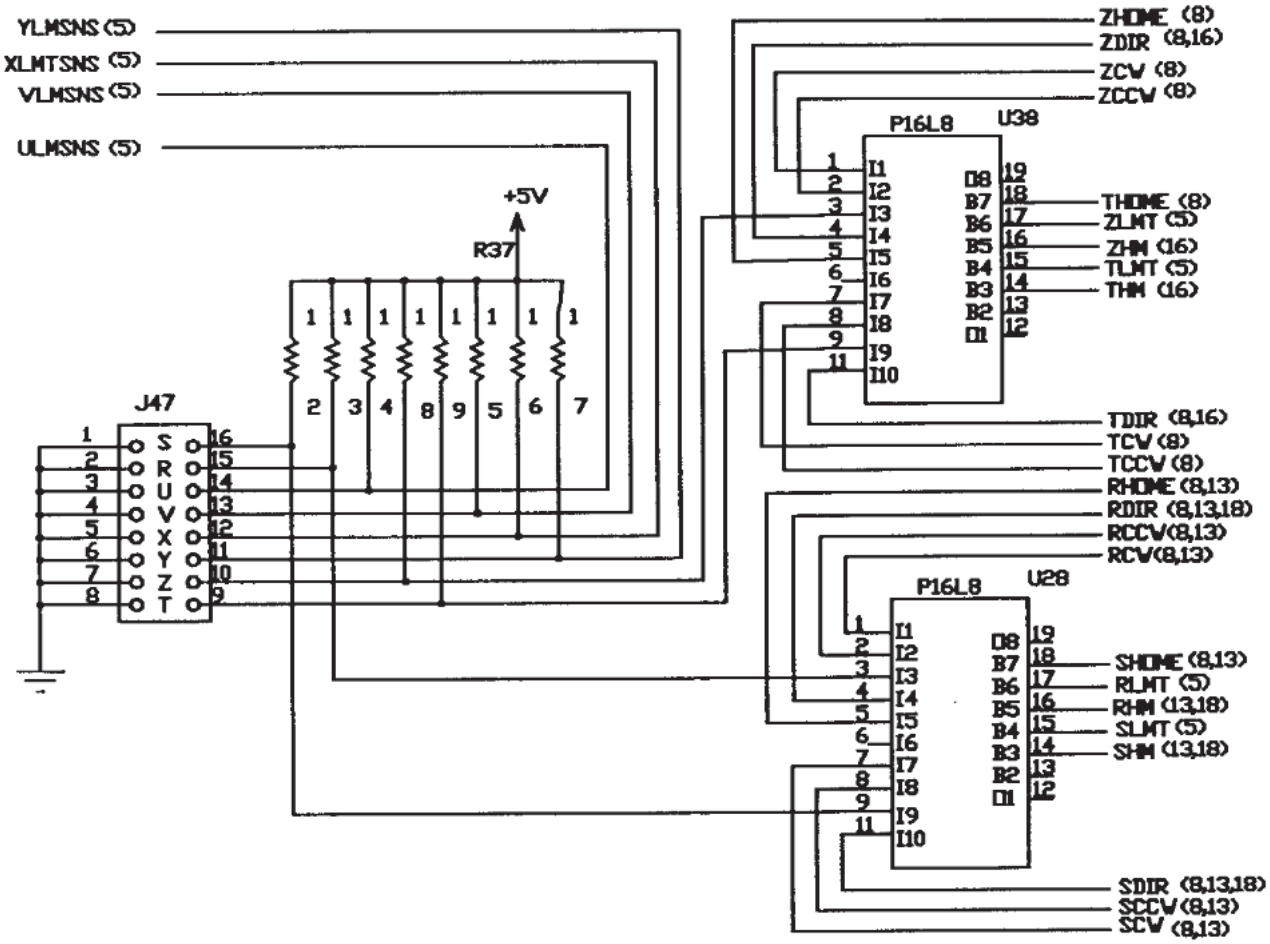


Figure 5-10: U14C Control Board Schematic (con't)

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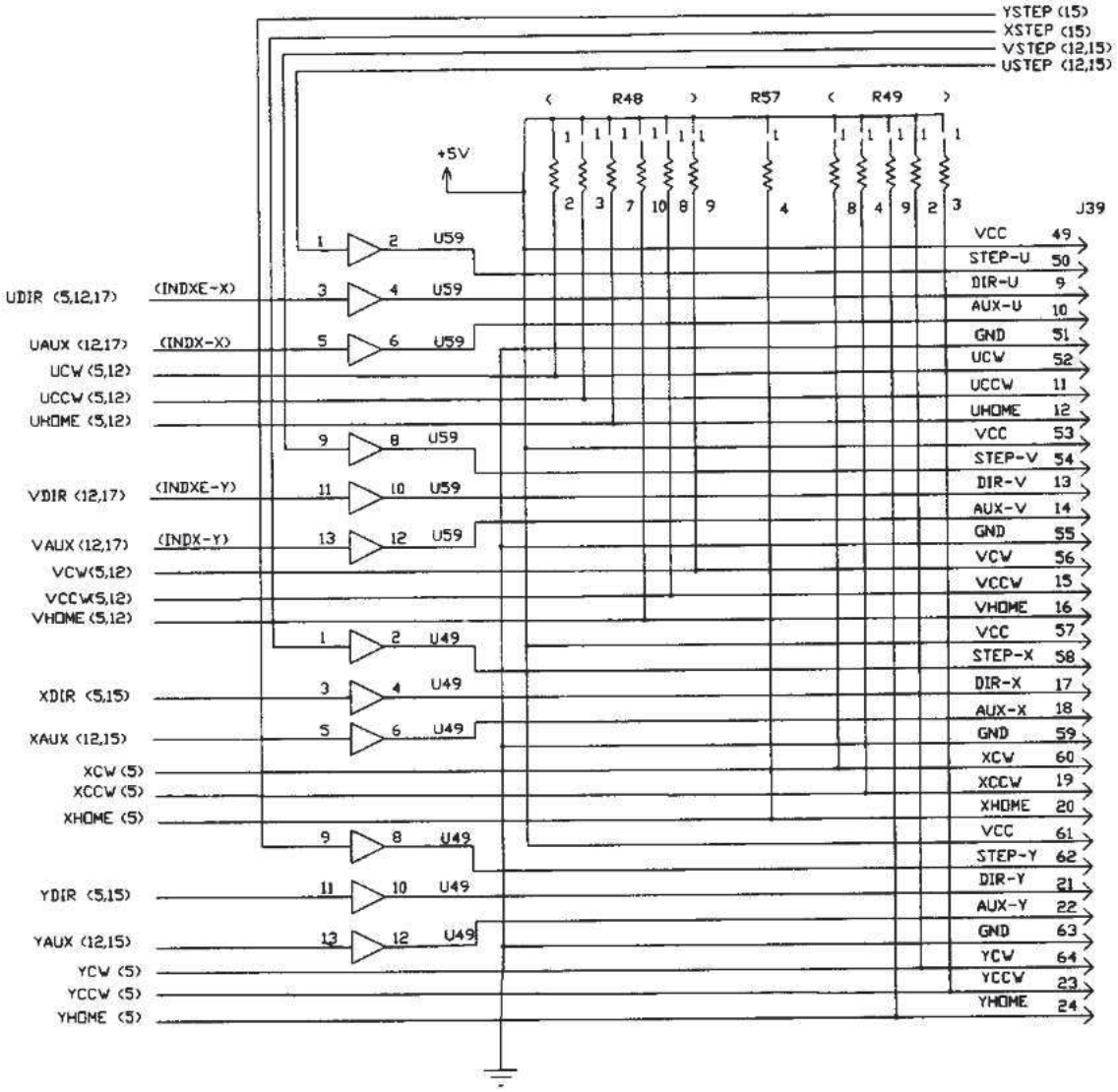


Figure 5-11: U14C Control Board Schematic (con't)

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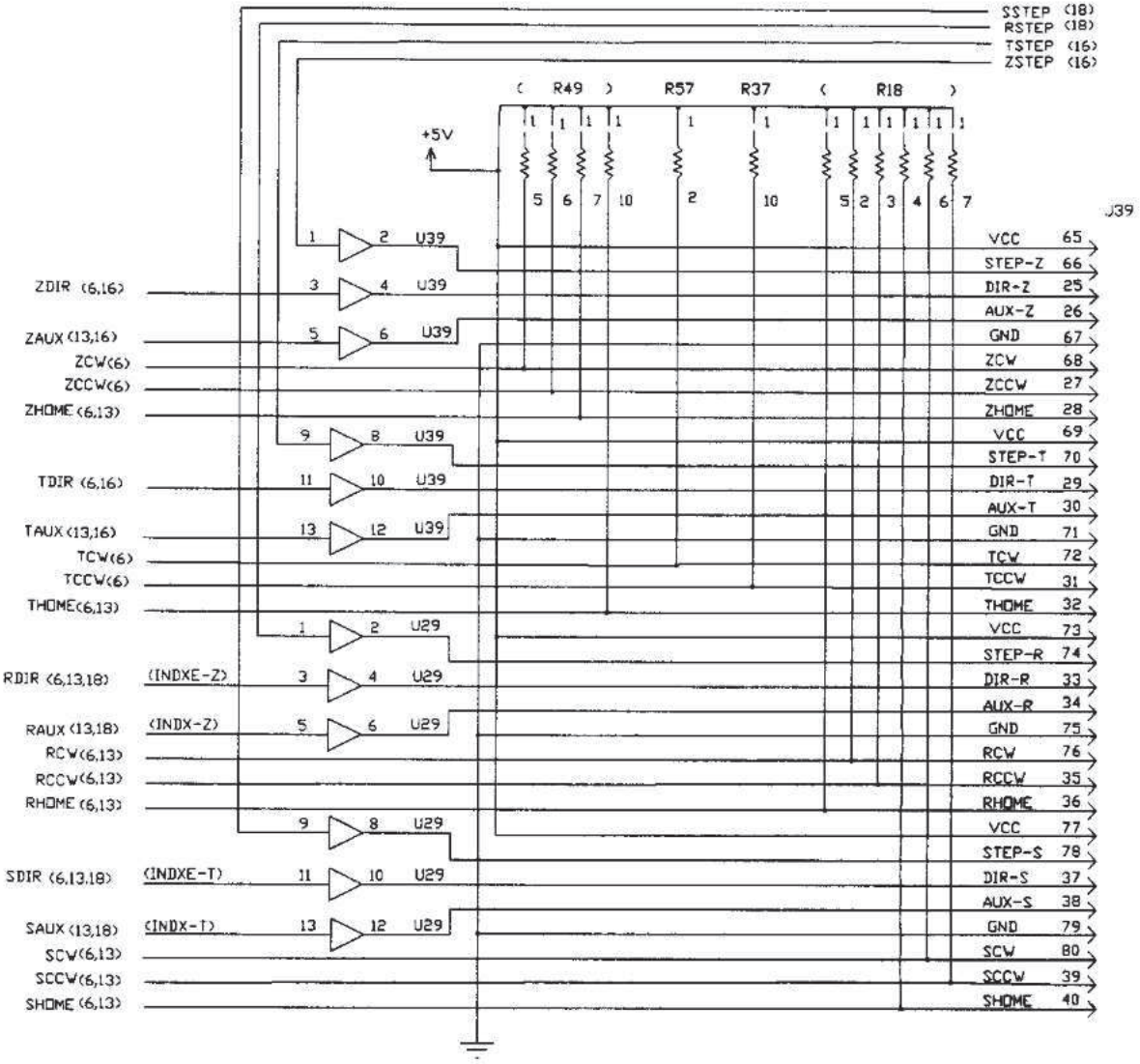


Figure 5-12: U14C Control Board Schematic (con't)

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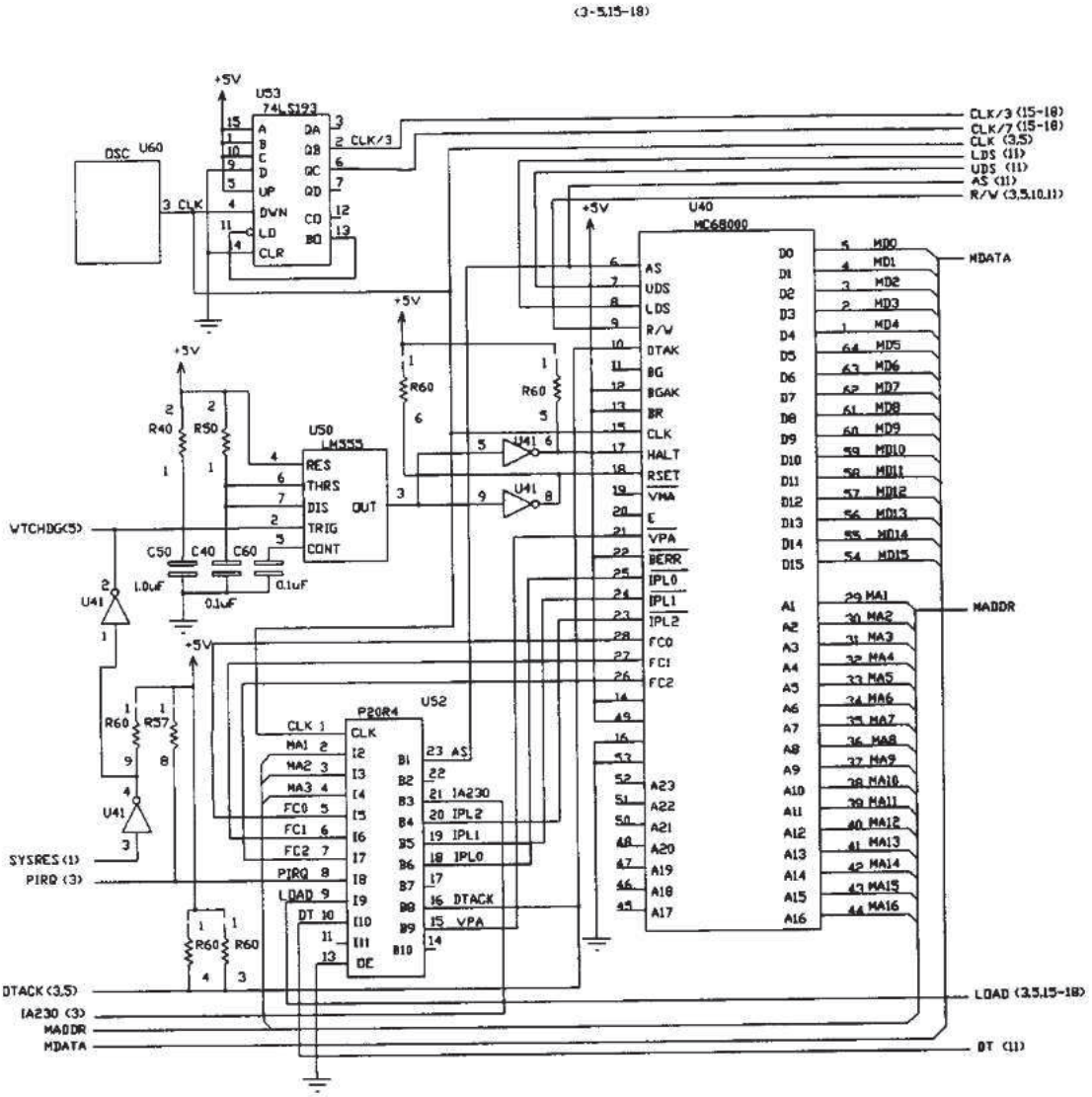


Figure 5-13: U14C Control Board Schematic (con't)

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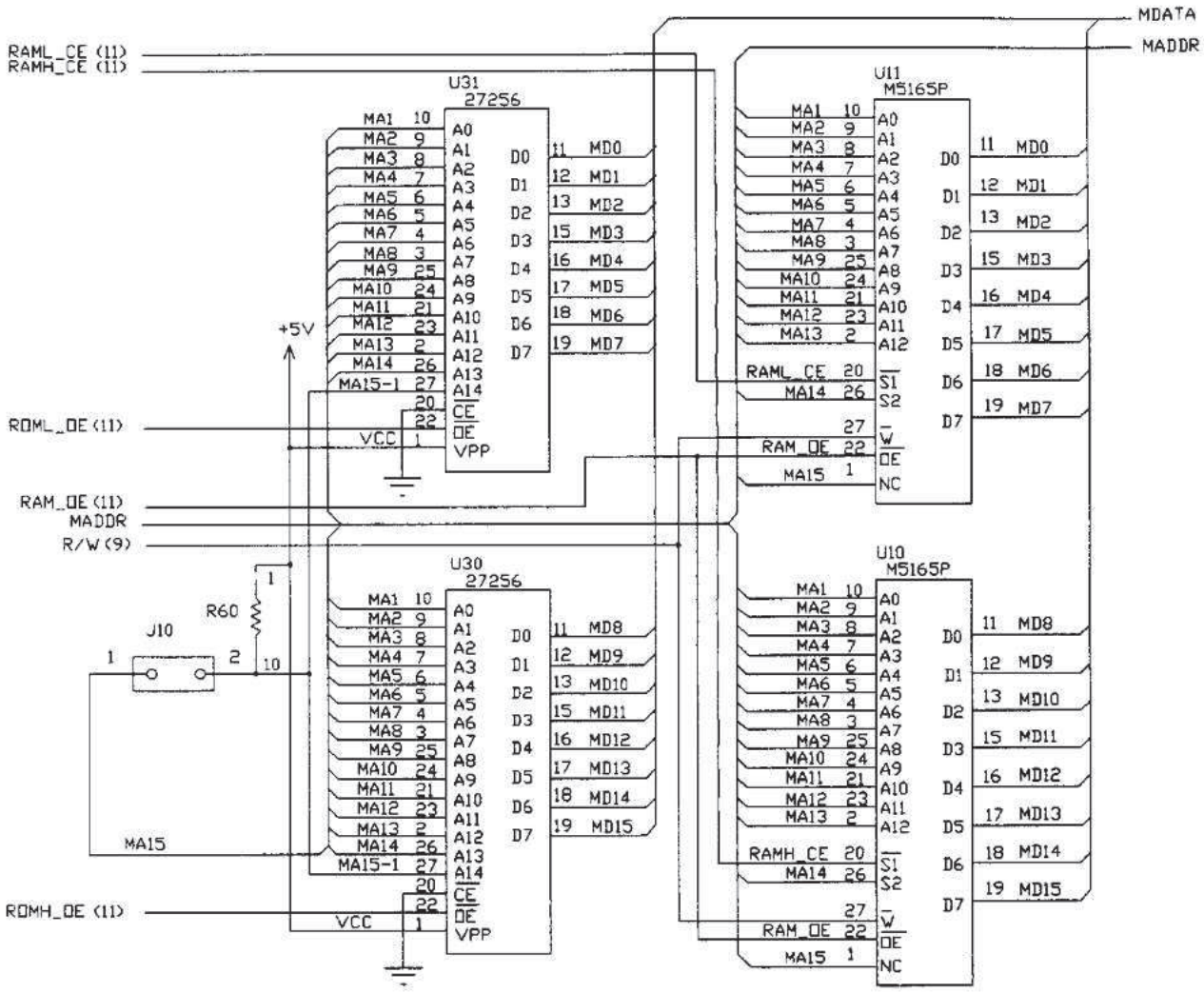


Figure 5-14: U14C Control Board Schematic (con't)

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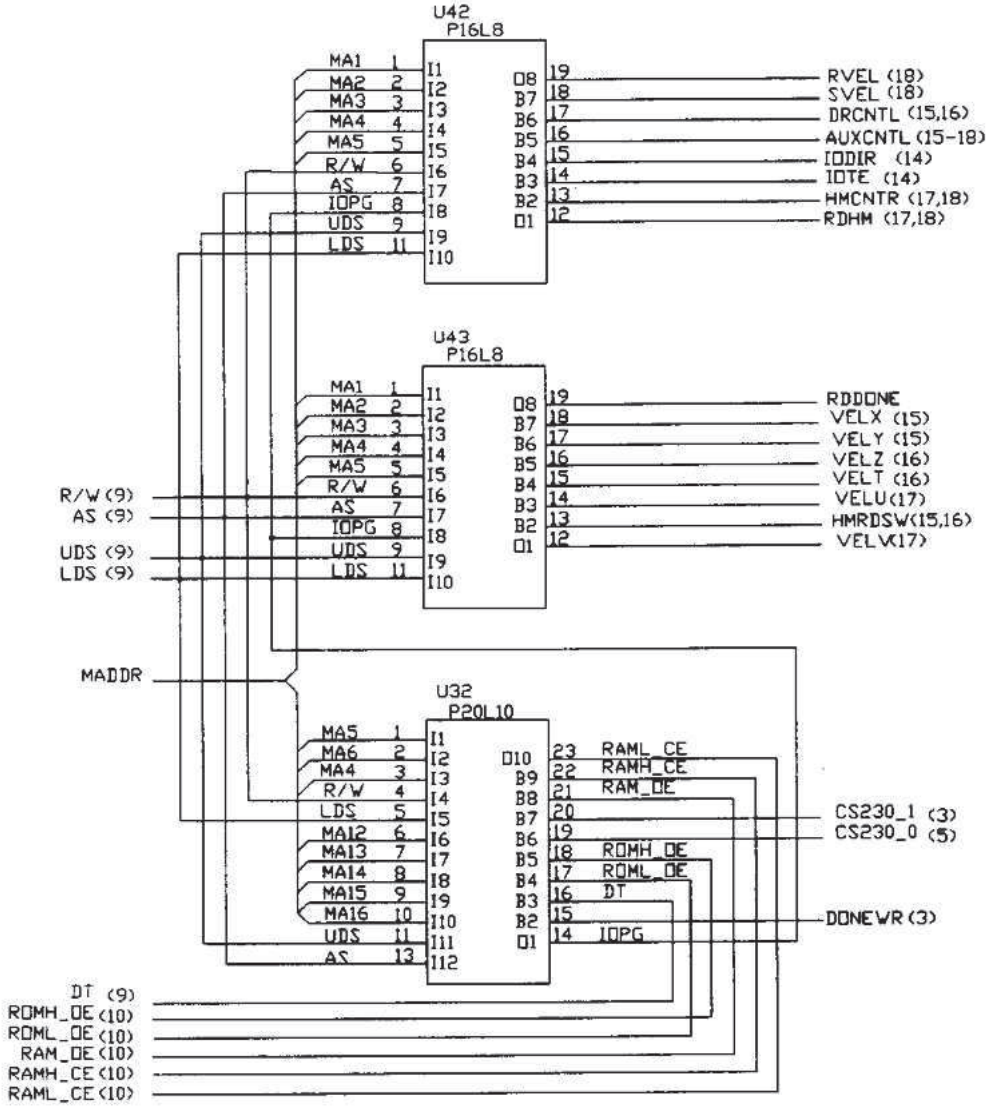


Figure 5-15: U14C Control Board Schematic (con't)

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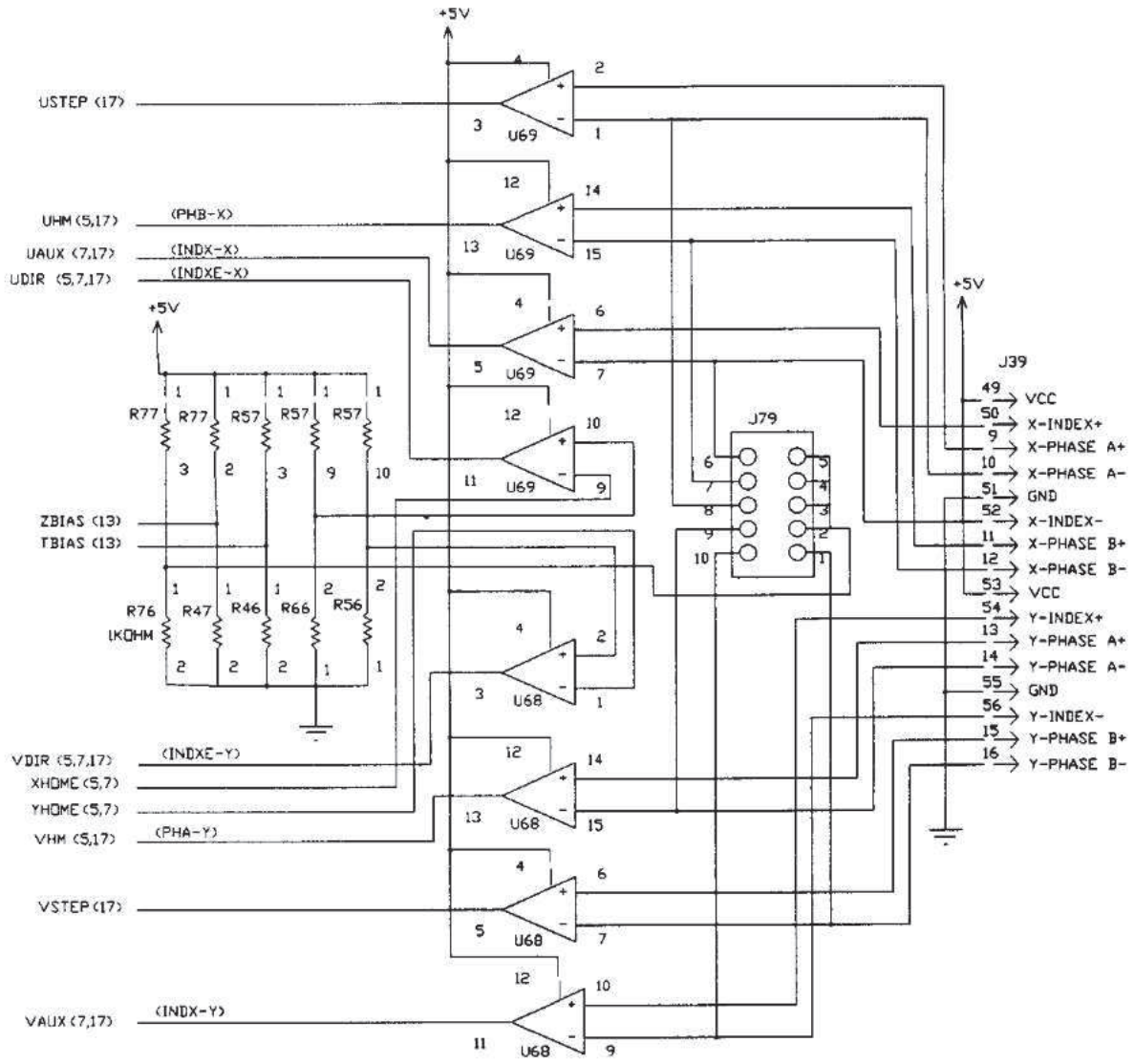


Figure 5-16: U14C Control Board Schematic (con't)

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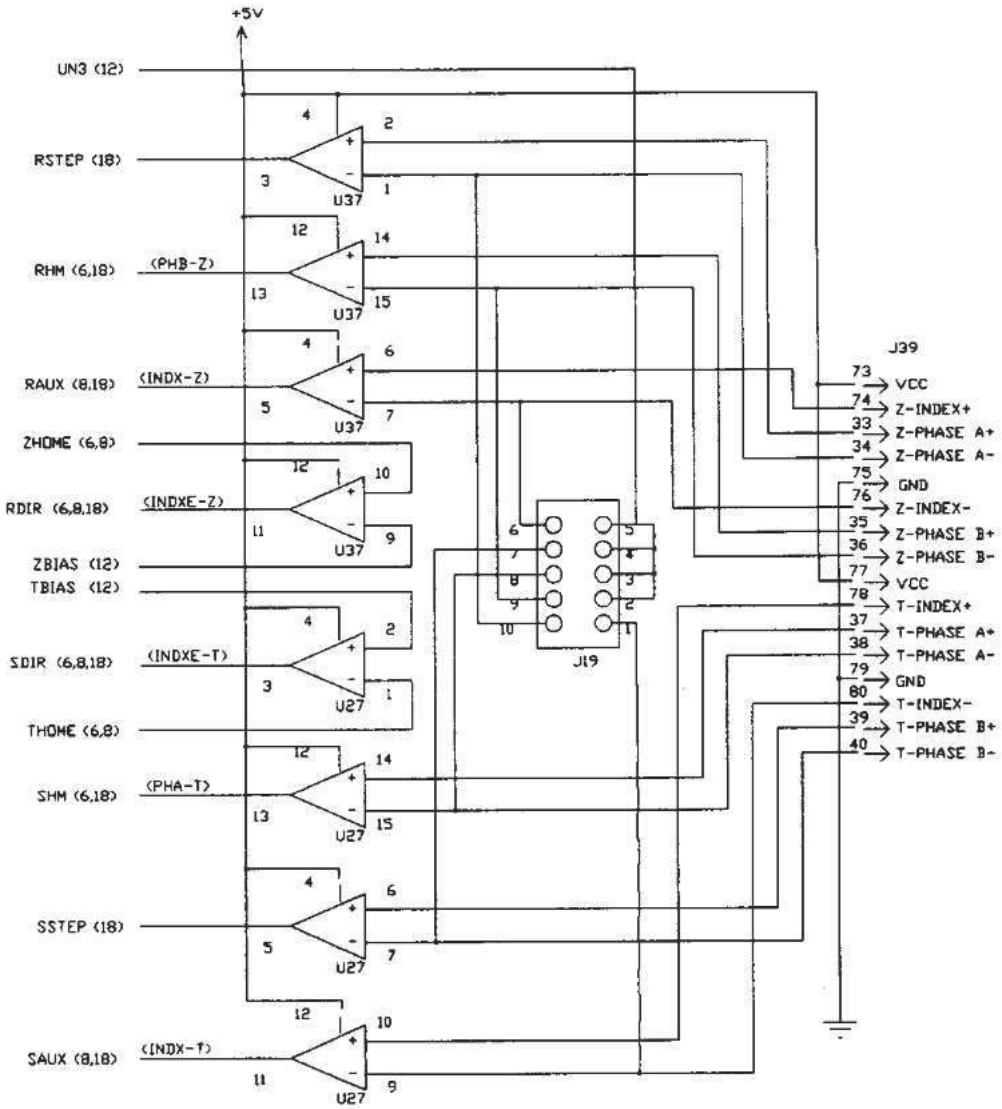


Figure 5-17: U14C Control Board Schematic (con't)

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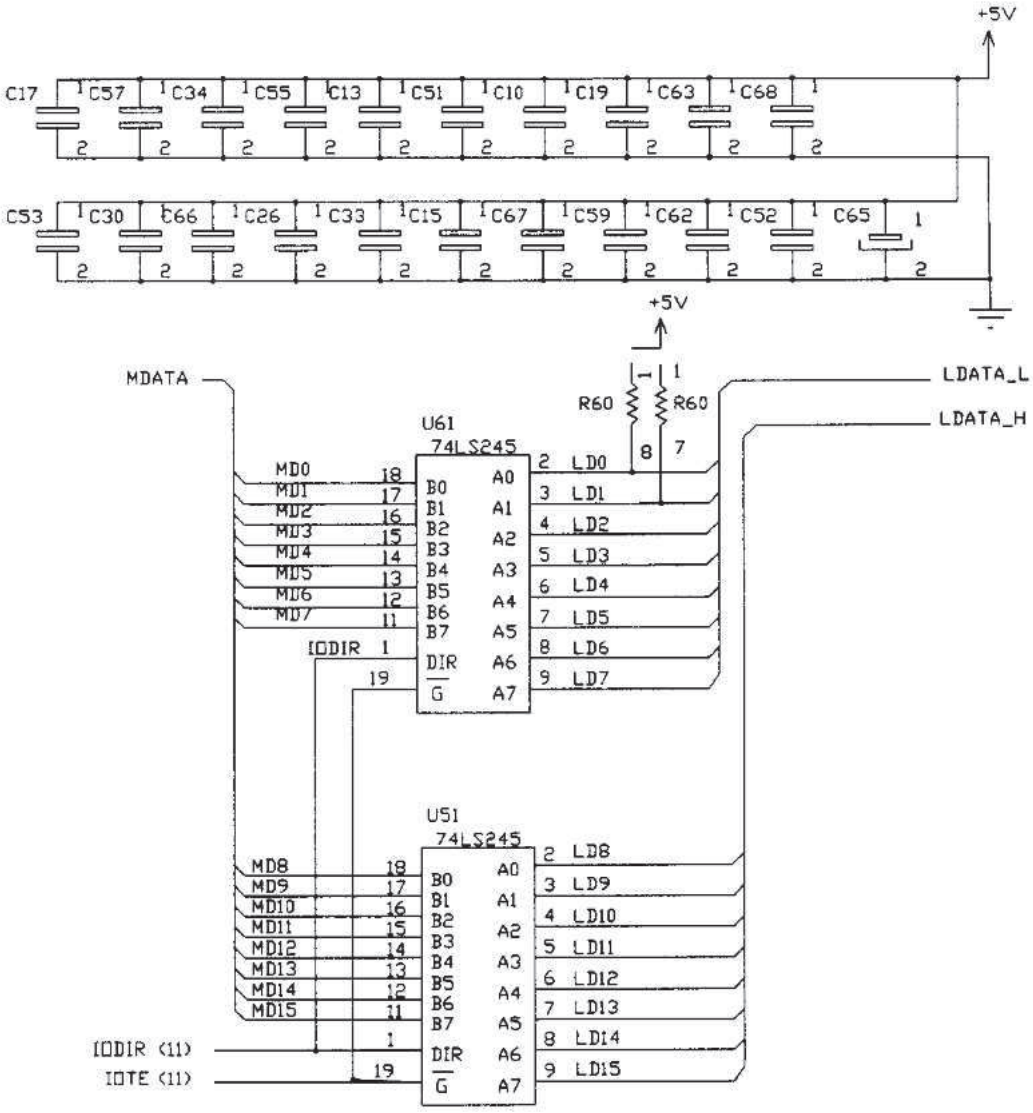


Figure 5-18: U14C Control Board Schematic (con't)

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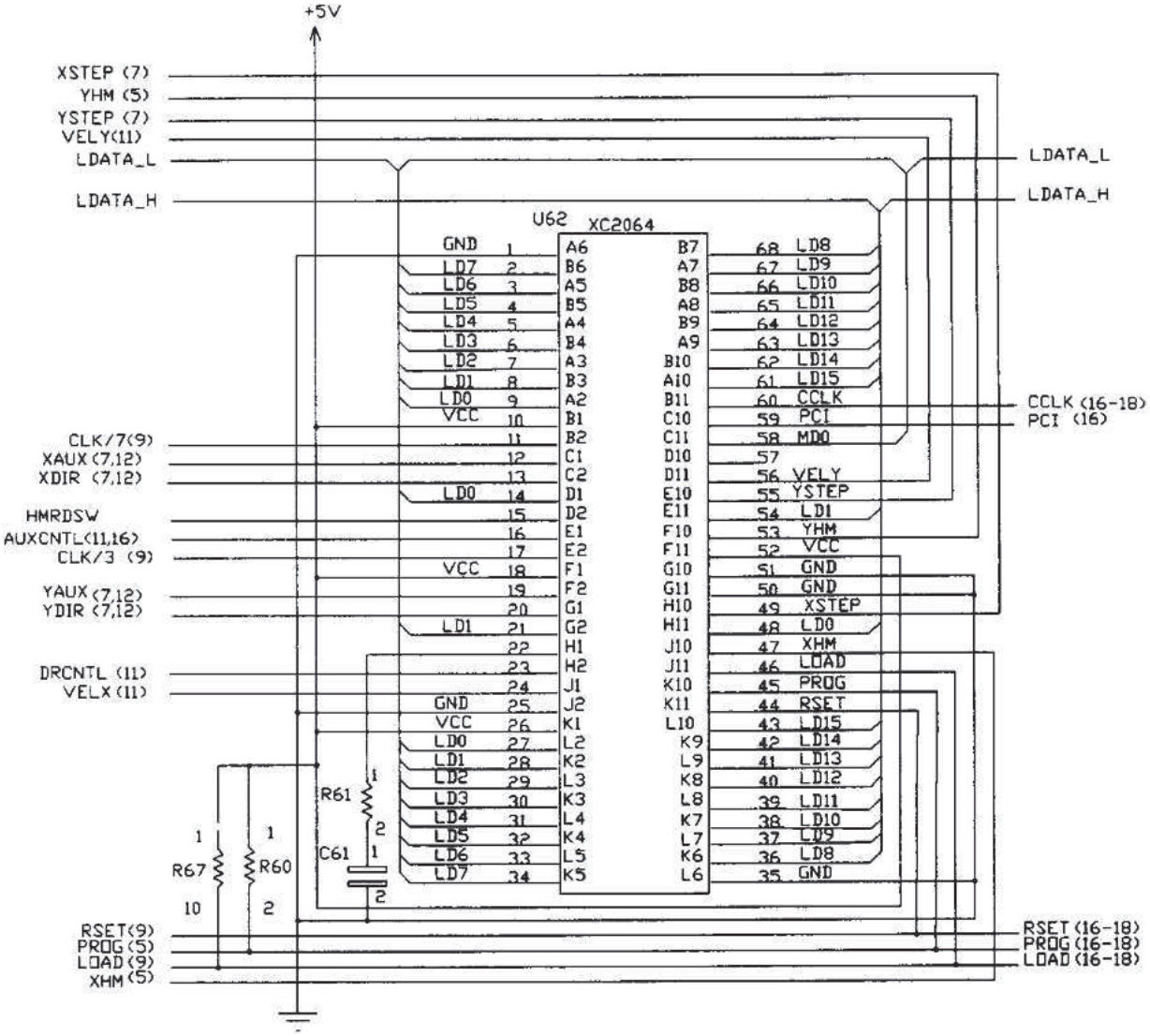


Figure 5-19: U14C Control Board Schematic (con't)

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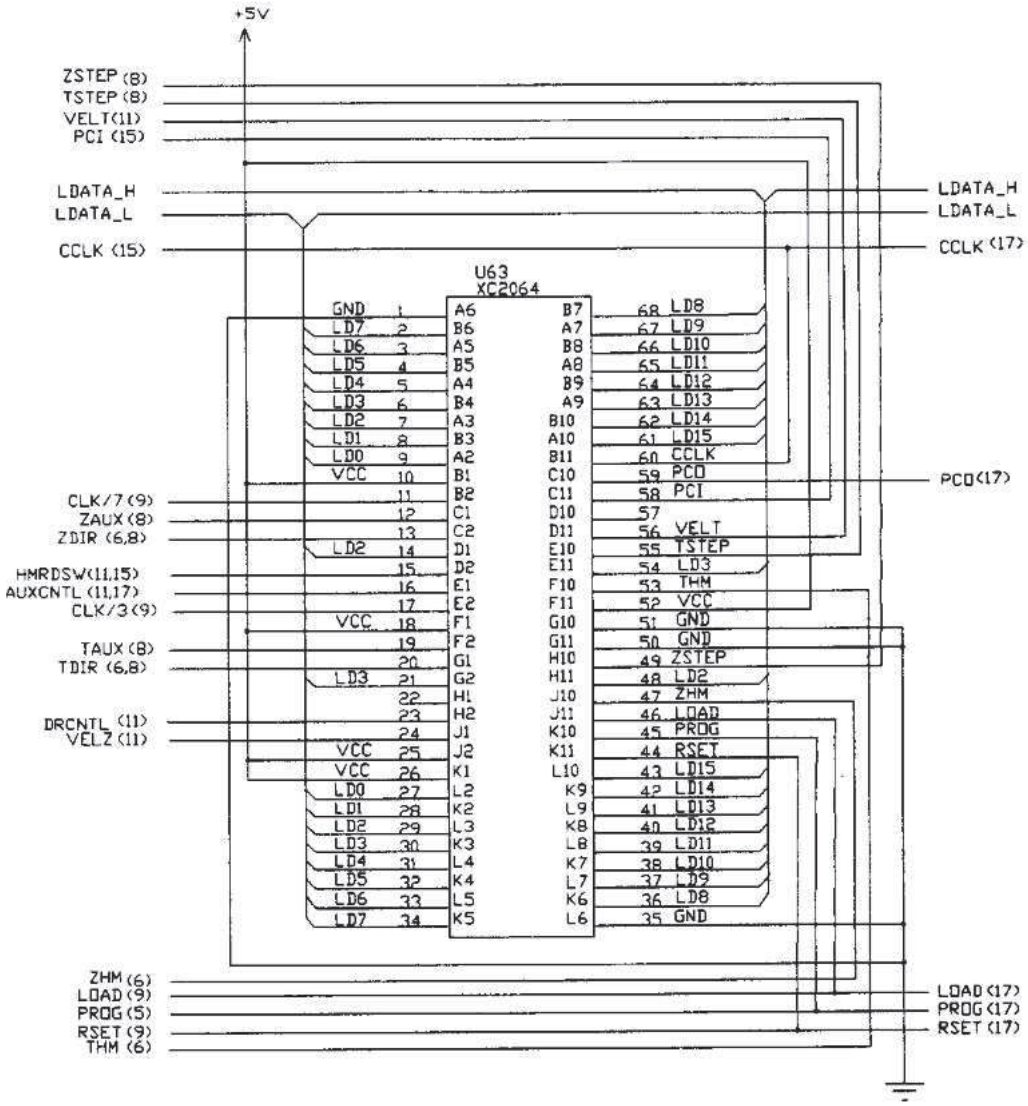


Figure 5-20: U14C Control Board Schematic (con't)

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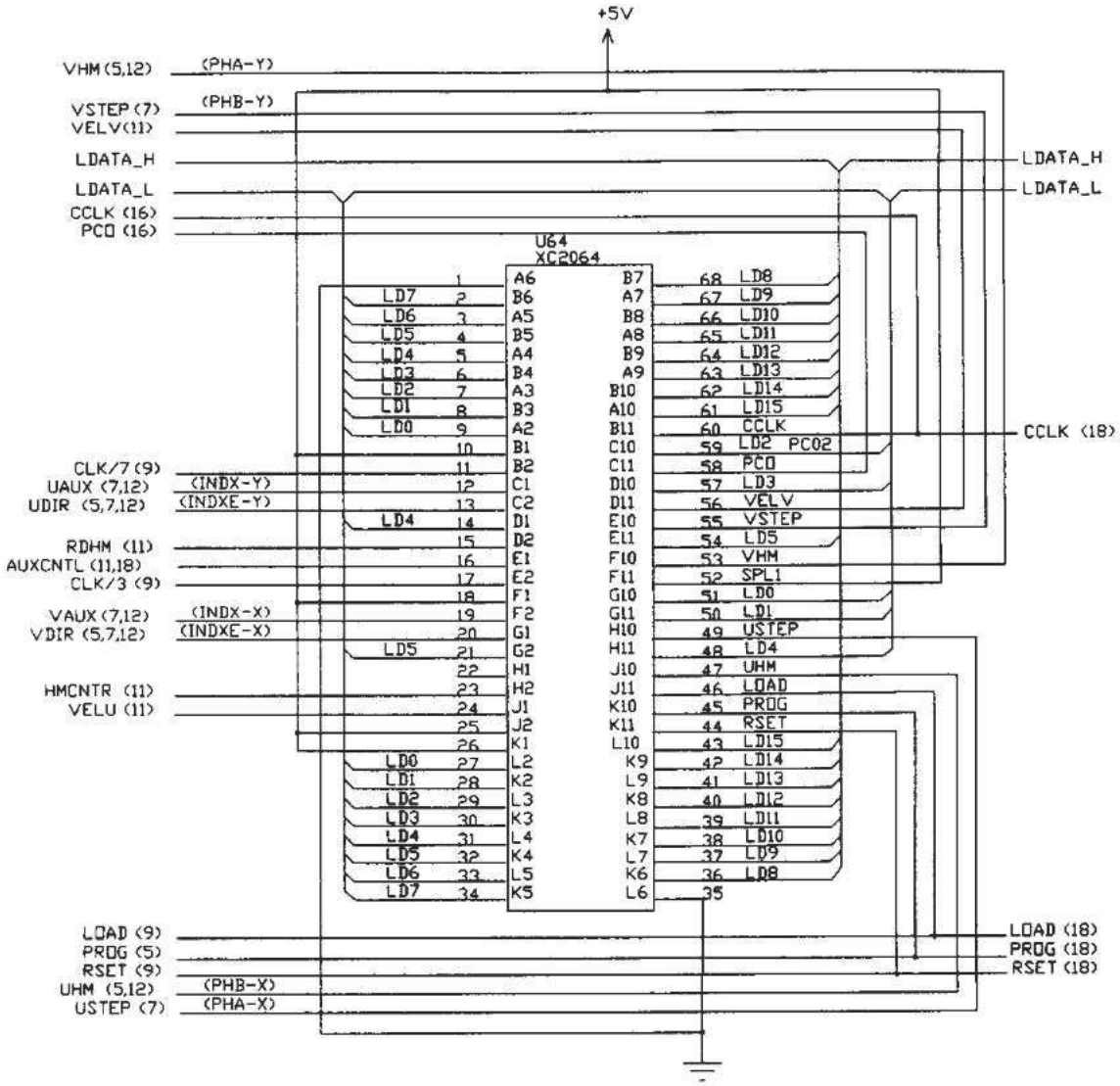


Figure 5-21: U14C Control Board Schematic (con't)

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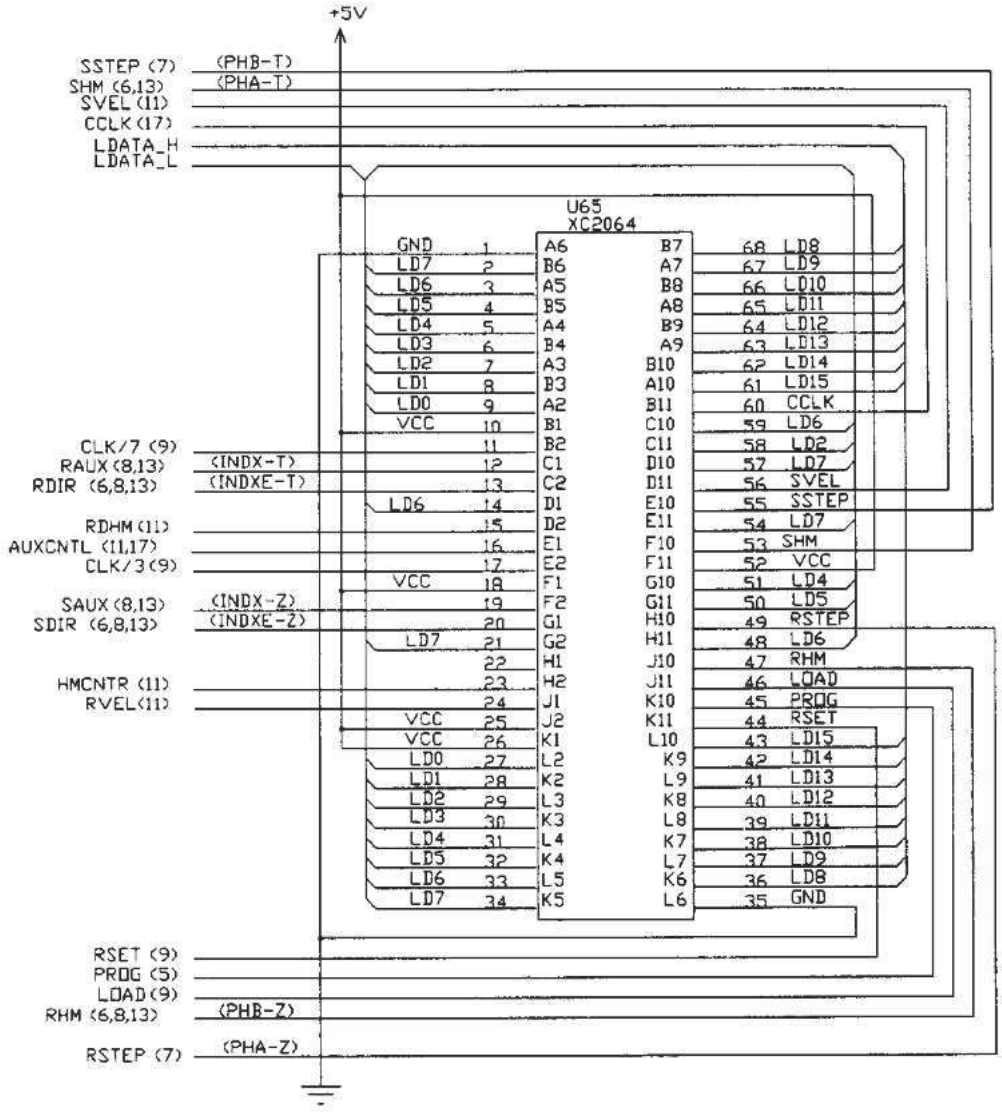


Figure 5-22: U14C Control Board Schematic (con't)

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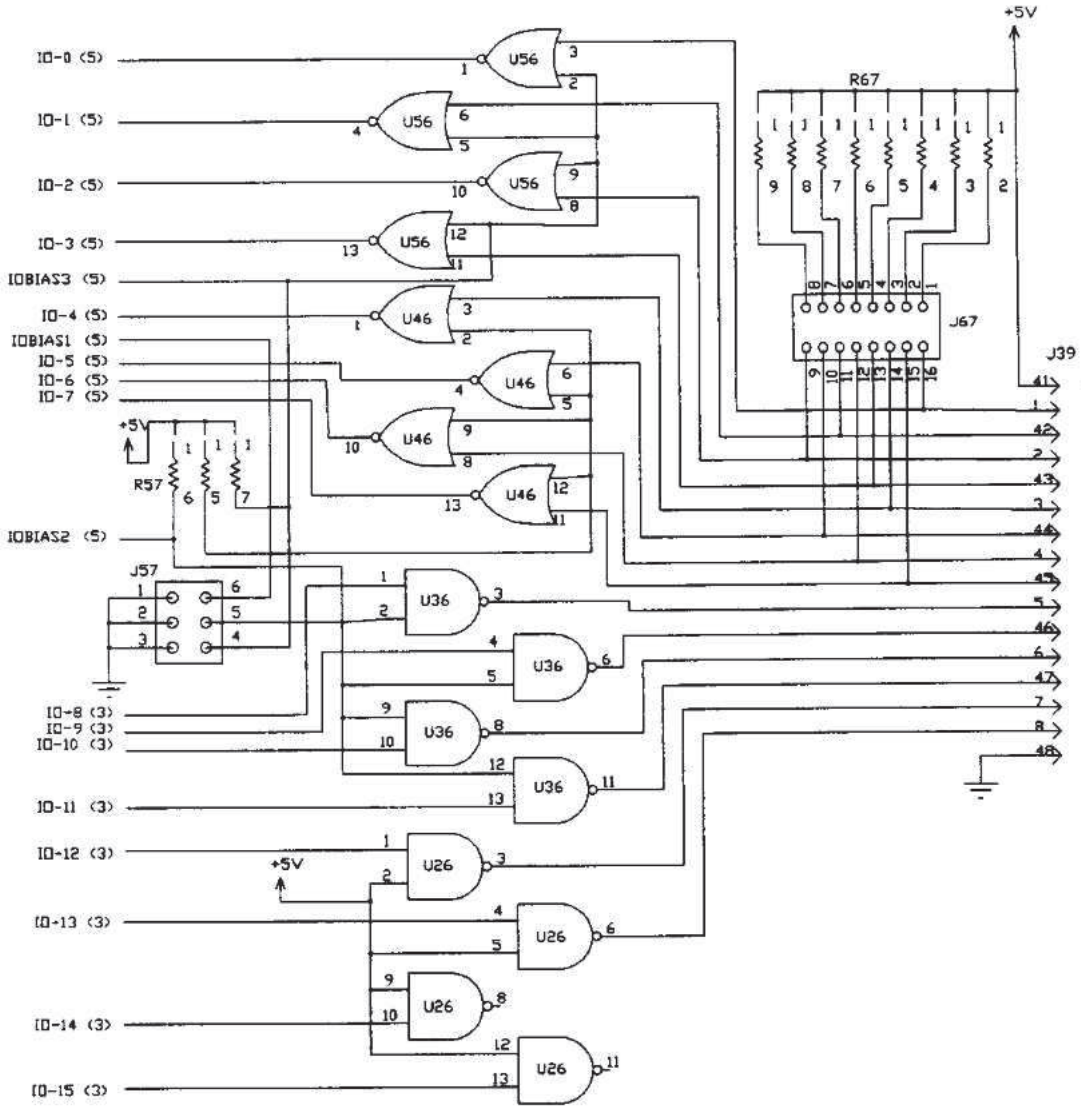


Figure 5-23: U14C Control Board Schematic (con't)

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CHAPTER 6: DRIVE MODULES

CONTROL AND POWER BOARD SPECIFICATIONS

Specifications for the Stepping Motor drive modules, DC Servo Drive modules, Aerodrive modules, Power Supply module, and Control module are described in this section.

Information provided for each module described in the following section is limited to the description of the various operational alterations that may be performed on a given module. An example of an alteration may be the re-selection of the "Homing" direction from CCW motor rotation to CW motor rotation.

IMPORTANT: Throughout this manual whenever reference is made to CW and/or CCW motor rotation, it is assumed that the user is "looking into" the motor mounting flange.

SECTION 6-1: STEPPING DRIVES

6-1-1: DM4001 and DM4005 STEPPING DRIVES

6-1-1-1: CIRCUIT DESCRIPTION

The DM4005 and DM4001 are designed to accurately control a standard unipolar Stepping motor by utilizing a unique sin/cos Translator control. This control is capable of dividing a full step size into 250 evenly spaced micro steps. For a 50 pole 200 full-step Stepping motor, this subdivision of a full step provides electrical resolutions of up to 50,000 steps per revolution. This sin/cos translator control, can be easily altered to provide other step sizes. By simply programming two IC chips, a host of other incremental step sizes can be chosen, ranging from 200 steps/rev (full step) up to 50,000 steps/rev in 200 step intervals. In other words, there are 250 choices of stepping resolutions.

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Another feature unique to the DM4005 and DM4001 is the totally integral power supply circuit. Stepping motor voltages as well as all logic control voltages (+5 and ±12VDC) are generated on the board. The only incoming power connection necessary is a standard 115VAC 50/60 Hz (nominal) or a 230VAC 50/60 Hz line connection. Thus, the DC bus power supply subsystem of the U14S and U14R chassis (transformer T1 and/or T2 with capacitors C1, C2, C3 and C4, see Figures 5-1 and 5-2) is not required. The power supply board module (described in this chapter) is *not* required when using this drive module.

An outline of the DM4001 and DM4005 drive modules is shown in Figure 6-1. Table 6-1 provides specifications for the DM4001 and DM4005. Torque/Speed curves are provided in Figure 6-2.

This module can be used in an Unidex 14 chassis (U14S and U14R).

6-1-1-2: "HOME" REFERENCE DEFINITION AND OPTIONS

All Unidex 14 Controllers are capable of generating a cold start reference position, which is the "Home" position. The basic Home cycle involves the following series of events. When the "Go Home" command has been issued, the motor will turn CCW (standard) or CW (optional) until a "Home Limit Switch" activation occurs.

NOTE: The CCW and CW rotational references are viewed, "looking into" the motor mounting flange.

Upon "Home Limit Switch" activation, the motor reverses and rotates in the opposite direction until the switch deactivates. If a "Marker" pulse option does not exist, upon switch deactivation, the motor will reverse and stop. If a "Marker" pulse option does exist (see Section 6-1-1-3), the motor reverses and continues to rotate until the "Marker" pulse is located and then stops.

The speed at which the Home cycle occurs is factory set at 120 RPM. If a different speed is required, see Section 6-1-1-7 for appropriate Personality module changes.

For most rotary motion stages, the "Home Limit Switch" referenced above is an independent switch incorporated specifically for the "Home" cycle. For linear motion stages, the "Home Limit Switch" could be an independent switch as well. However, in most cases, the CCW or CW limit switches perform "double duty" and act as the "Home Limit Switch". (Note that the process of putting the "Home Limit Switch" input in parallel with the CCW or CW limit switch input is standardly done at the motor/stage, external to the Unidex 14.)

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The "Home Limit Switch" wiring to either a CW or CCW limit switch is done at the motor/stage external to the Unidex 14.

If it is not possible to use the "Home Limit" input at J13, 14, 19, or 20, such as when Opto 22 coupled limits are being used, the "CCW" or "CW limit" input may be paralleled to the "Home Limit" input by reconfiguring jumpers 16 through 19 on the DM4005/DM4001 PC board. Note that this scheme is possible only with linear stages and not with rotary states.

The jumper definition follows:

HOME LIMIT SOURCE:

(Standard) From Home Limit Input: Jumper 17-19, Remove 16-19,18-19
(Optional) From CCW Limit Input: Jumper 16-19, Remove 17-19,18-19
(Optional) From CW Limit Input: Jumper 18-19, Remove 16-19,17-19

See Figure 6-1 for jumper locations.

When the Home command is issued, the standard direction of motor rotation is CCW. If CW rotation is required, jumpers 23-24-25 on the DM4005 and DM4001 board must be reconfigured.

The jumper definition follows:

(Standard) CCW Home - Jumper 23-24, Remove 24-25
(Optional) CW Home - Jumper 24-25, Remove 23-24

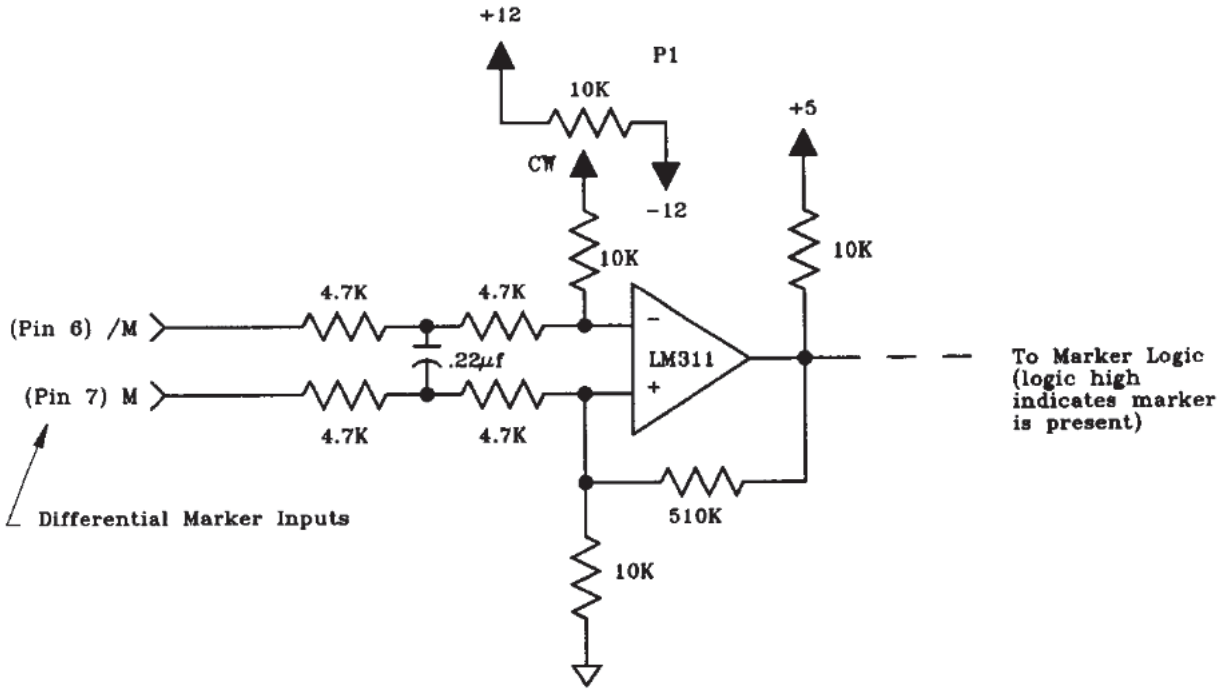
See Figure 6-1 for jumper locations.

NOTE: Positive move commands to the Unidex 14 turns the motor CCW (when looking into the flange).

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6-1-1-3: OUTLINE OF MARKER BUFFER CIRCUIT:

Shown below is a circuit diagram of the differential Input Marker circuit:



Potentiometer P1 (see Figure 6-1) in the circuit diagram above, allows the threshold of the Marker input signal to be adjusted. The threshold level is increased by turning P1 CW. To activate the Marker logic, the voltage signal at "M" must rise slightly higher than the voltage signal at "/M", plus the threshold setting at P1. In other words:

M > /M + P1 (threshold)

For a TTL Marker connection, the signal common of the TTL circuit should be tied to signal common and the Marker tied to "M". P1 should be adjusted to +1VDC at the P1 wiper.

NOTE: P1 will be factory set such that proper "Home Cycle" operation will occur when the Marker option is absent or when interfacing to an Aerotech stage/motor with a "Home Marker" (HM) option. This setting is approximately -1VDC at P1 wiper.

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6-1-1-4: LIMIT SWITCH POLARITY SELECTION

As a standard, Unidex 14 Controllers are configured to interface to normally open (active low) limit switches (CCW, CW and Home). If use of normally closed (active high) limit switches is required, jumpers 1 through 6 and 13 through 15 on the DM4005 and DM4001 board must be reconfigured.

The jumper definitions follow:

(Standard) CCW Limit, Normally Open - Jumper 1-2, Remove 2-3
(Optional) CCW Limit, Normally Closed - Jumper 2-3, Remove 1-2
(Standard) CW Limit, Normally Open - Jumper 5-6, Remove 4-5
(Optional) CW Limit, Normally Closed - Jumper 4-5, Remove 5-6
(Standard) Home Limit, Normally Open - Jumper 13-14, Remove 14-15
(Optional) Home Limit, Normally Closed - Jumper 14-15, Remove 13- 14

See Figure 6-1 for jumper locations.

6-1-1-5: +/- DIRECTION DEFINITION AND OPTIONS

When a "+" direction is programmed into a Unidex 14, the motor will rotate in the CCW direction.

NOTE: CW and CCW rotational references are viewed as "looking into" the motor mounting flange.

When a "-" direction is programmed, the motor will rotate in the CW direction. If the opposite convention is required, jumpers 20-21-22 may be reconfigured.

The jumper definition follows:

(Standard) "+" = CCW, "-" = CW - Jumper 21-22, Remove 20-21
(Optional) "-" = CCW, "+" = CW - Jumper 20-21, Remove 21-22

See Figure 6-1 for jumper locations.

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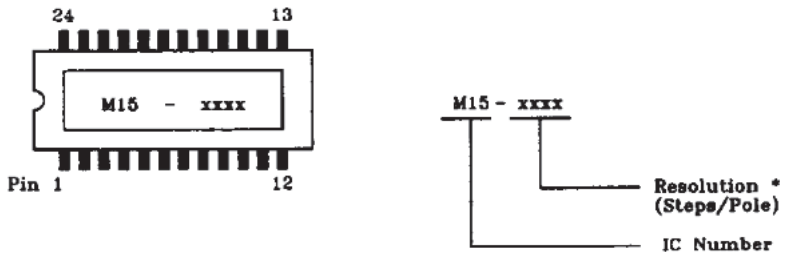
6-1-1-6: SELECTING STEPPING MOTOR RESOLUTION

The DM4005 and DM4001 series can be programmed to drive a Stepping motor at 250 different Stepping resolutions. As was described in part (6-1-1-1 (circuit description), a Stepping resolution range can be selected between 200 Steps/Rev and 50,000 Steps/Rev inclusive, in increments of 200 steps (i.e., 200, 400, 600,....49600, 49800 and 50000 Steps/Rev).

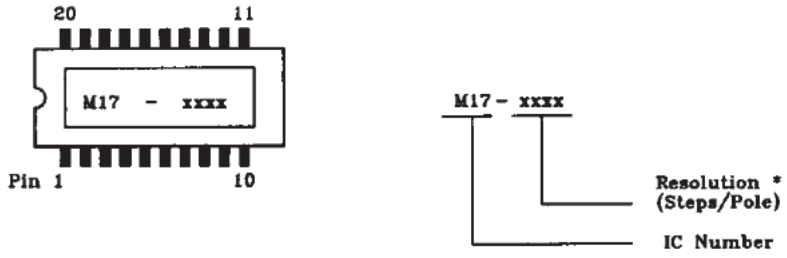
The changing of resolution on the DM4005 and DM4001 involves the programming of two IC chips, M15 and M17. This programming cannot be done in the field. However, M15 and M17 are easily changed in the field since both ICs are mounted on IC sockets.

The part numbering system for M15 and M17 is shown below. These part numbers must be used when ordering different control resolutions.

For IC M15:



For IC M17:



*NOTE: This number defines the resolution (Steps/Pole)
For example:

POLE RESOLUTIONS
(STEPS/POLE)

1000	⟶	50000 Steps/Rev	For standard
720	⟶	36000 Steps/Rev	motors
80	⟶	4000 Steps/Rev	(1.8° /full step)
16	⟶	800 Steps/Rev	

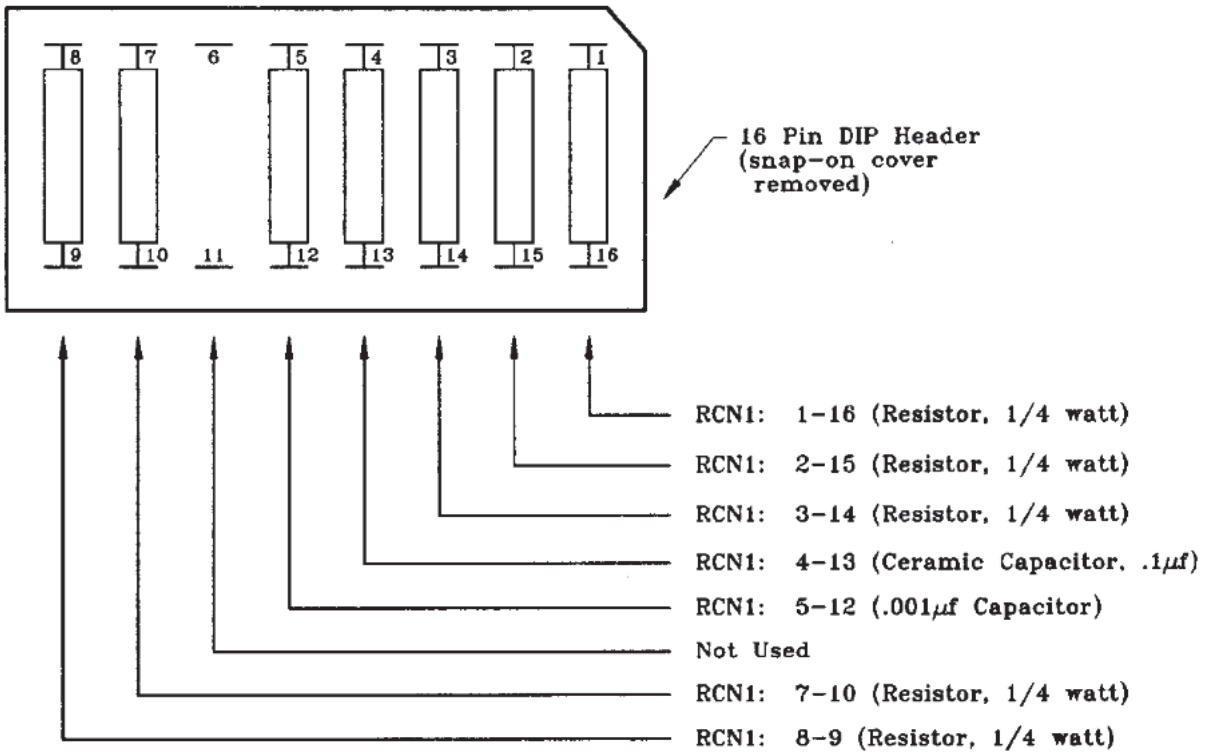
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The Step/Rev numbers listed above apply to a 50-pole, 1.8 degree per full step Stepping motor. When determining Step/Rev for other multiple pole motors, multiply the given steps/pole resolution by the number of poles for the given Stepping motor. The resulting number will then be the Step/Rev resolution for that motor.

When changing resolutions, it is common to change Personality Module RCN1 also, so that Home speed and Slew speed (if applicable) vary according to resolution.

6-1-1-7: PERSONALITY MODULE (RCN1)

The Personality Module is a 16-pin DIP wafer consisting of 5 resistors and 2 capacitors. This module contains all of the parameters used to match a given Stepping Motor with a given resolution for the DM4005 or DM4001. A representation of a Personality Module is shown below (see also Figure 6-1).



The parameter settings of RCN1 are explained in the following subsections.

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6-1-1-8: RCN1: 8-9, HOME CLOCK OSCILLATOR ADJUSTMENT

The adjustment for the Oscillator which sends the Stepping Motor into a limit involves RCN1: 8-9. This value can be determined as follows:

$$\text{Home Clock Frequency (Hz)} \sim \frac{1}{1.5(.001\text{x}10^{-6})\ (\text{RCN1: 8-9})}$$

Where RCN1: 8-9 is in ohms

6-1-1-9: RCN1: 3-14 AND RCN1: 2-15, LO/HI CURRENT LEVELS

The low current level (standby current when motor is at rest) is set by RCN1: 2-15. This value of current can be calculated as follows:

$$\text{Standby Current Level (amps)} = N\ \frac{1 \text{ x } 10^4}{\text{RCN1: 2-15}}$$

Where RCN1: 2-15 is in ohms
N = 1 for DM4001
N = 5 for DM4005

The high current level (running current) involves the selection of RCN1: 3-14 and RCN1: 2-15 (determined above). The value can be calculated as follows:

$$\text{Running Current Level (amps)} = N\ \frac{1 \text{ x } 10^4}{\text{RCN1: 2-15}} + \frac{1 \text{ x } 10^4}{\text{RCN1: 3-14}}$$

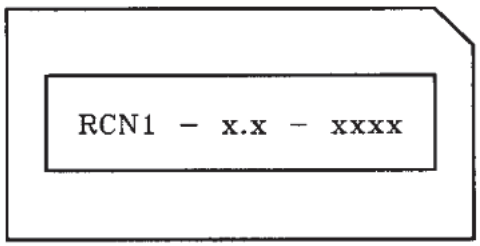
Where RCN1: 2-15 and RCN1: 3-14 are in ohms
N = 1 for DM4001
N = 5 for DM4005

NOTE: RCN1: 1-16, RCN1: 4-13, RCN1: 6-11 and RCN1: 5-12 are factory selected for the DM4001 and DM4005 Series. These components should never be changed by the user.

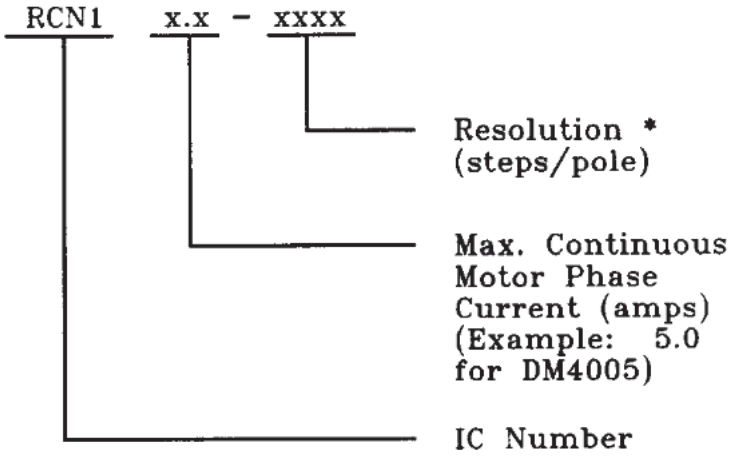
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The DM4005 and DM4001 are shipped with standard Personality modules, which are defined by the resolution and rated phase current of the Stepping motor being used. If the DM4000 Series is being used with a standard Aerotech Stepping motor, the user need only define the desired resolution in which the motor is to operate. If the DM4000 Series is not being used with a standard Aerotech motor, the user must define the type of Stepping motor being used, with its rated phase current, as well as the DM4000 Series resolution in which it is to operate.

A list of Personality modules used with standard Aerotech stepping motors is provided following the next illustration. A label on the Personality modules defines the resolution (of the internal oscillators) and motor phase current parameters for that module. If the user is not using Aerotech motors, a custom Personality module may be ordered using the part numbering format shown below. Given the rated current and resolution information for a particular motor, Aerotech will set the Slew oscillators, the Home oscillator and the Run/Standby phase current levels. Although it is not generally recommended, the user also has the option of changing the parameters of the Personality module using the equations listed in Section 6-1-1-8, and 6-1-1-9.



PERSONALITY MODULE RCN1



* **NOTE:** This number defines the resolution (in steps per pole), for which the slew and Home oscillator, as well as the current levels of the Personality module, are "tailored" to operate.

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