# UNIDEX™ 16
# MOTION CONTROLLER
# HARDWARE MANUAL

PN: EDU105

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**DISCLAIMER:**

The information contained in this manual is subject to change due to improvements in design. Though this document has been checked for inaccuracies, Aerotech does not assume responsibility for any errors contained herein.

**TRADEMARKS:**

Unidex is a registered trademark of Aerotech, Inc.

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Pamux 1 is a registered trademark of Opto 22.

The I/O Channel and I/Omodule are registered trademarks of Motorola, Inc.

**DOCUMENTATION FOR UNIDEX 16:**

Two manuals have been shipped with your Unidex 16 Motion Controller:

*Unidex 16 Motion Controller Programming Manual*
*Unidex 16 Motion Controller Hardware Manual* (this one)

**CAUTION:**

Before applying power or operating this equipment:

1. Read this manual and all documentation supplied with your system.

2. Verify the input power requirements - voltage, current and frequency.

3. Verify input power wiring compliances with this manual and with your local safety code.

*If you have any questions, please consult Aerotech, Inc.*

**NOTE:**

The standard power supply contained within your system is designed to operate Unidex 16 only. It should not be used to power external equipment. External power supplies are available upon special request.

# Table of Contents

# CHAPTER 1: INTRODUCTION

This manual is intended to be an aid in the installation of Unidex 16 systems. Unidex 16 systems are available in several forms. They are:

- Unidex 16 R Model
- Unidex 16 F Model
- Unidex 16 U Model
- Unidex 16 MPE-B Model

The Unidex 16 system may be ordered with a variety of options. For example: motors, encoders, output wiring, linear or rotary translation stages, etc.

Since Unidex 16 may be purchased as a Turn Key system or as OEM components, and there are many variations of the above mentioned standard models, this manual contains general information, as well as specific information whenever possible. For more information particular to your system, refer to your system drawings.

**NOTE:** When calling Aerotech concerning your system, please **have your SYSTEM SERIAL NUMBER on hand.** All information concerning your system is referenced through this number.

# CHAPTER 2: UNPACKING THE UNIDEX 16 SYSTEM

If there is any evidence of damage to the shipping container, request that the carrier's agent be present while the system is being unpacked and inspected.

If any damage is found, contact Aerotech's Customer Service Department.

Check the sales order slip accompanying your system to verify that all of the features, options and parts that have been ordered are included.

| |
|---|
| **CAUTION: IMPROPER HANDLING OF ELECTRICAL OR MECHANICAL DEVICES COULD ADVERSELY EFFECT THEIR PERFORMANCE.** |

# CHAPTER 3: POWER WIRING

## SECTION 3-1 POWER REQUIREMENTS

When Unidex 16 is powered by an Aerotech power transformer, the input power can be 104/115VAC, single-phase, 50/60 Hz, 30 amps, or 208/230VAC, single phase, 50/60 Hz, 15 amps.

The transformer size and input voltage will depend on the amplifiers and motors selected. It is not recommended to run equipment that has a high current requirement from a 115V circuit. Although 115V, 30A circuits are available, this does not make for a very good installation, due to the line drop when peak current is required during acceleration.

**CAUTION: ON THE REAR OR SIDE PANEL OF EACH MODEL IS A POWER REQUIREMENT LABEL. PLEASE NOTE THIS RATING BEFORE MAKING ANY CONNECTIONS. THIS LABEL LISTS VOLTS, AMPS AND FREQUENCY.**

The input power requirement label indicates the power required to operate the equipment properly. The AC current value is normally the rating of the input circuit protection device and is generally 150% of full load capability.

## SECTION 3-2 BLOCK DIAGRAM OF INPUT POWER

To make AC wiring easier to understand, figure 3-1, *Functional AC Power Wiring For Unidex 16 Systems*, offers a functional block diagram of Input Power and Emergency Stop Wiring. For more details, please consult your system drawings.

Please note that although figure 3-1 illustrates input power wiring using three axes, up to six axes may be used.

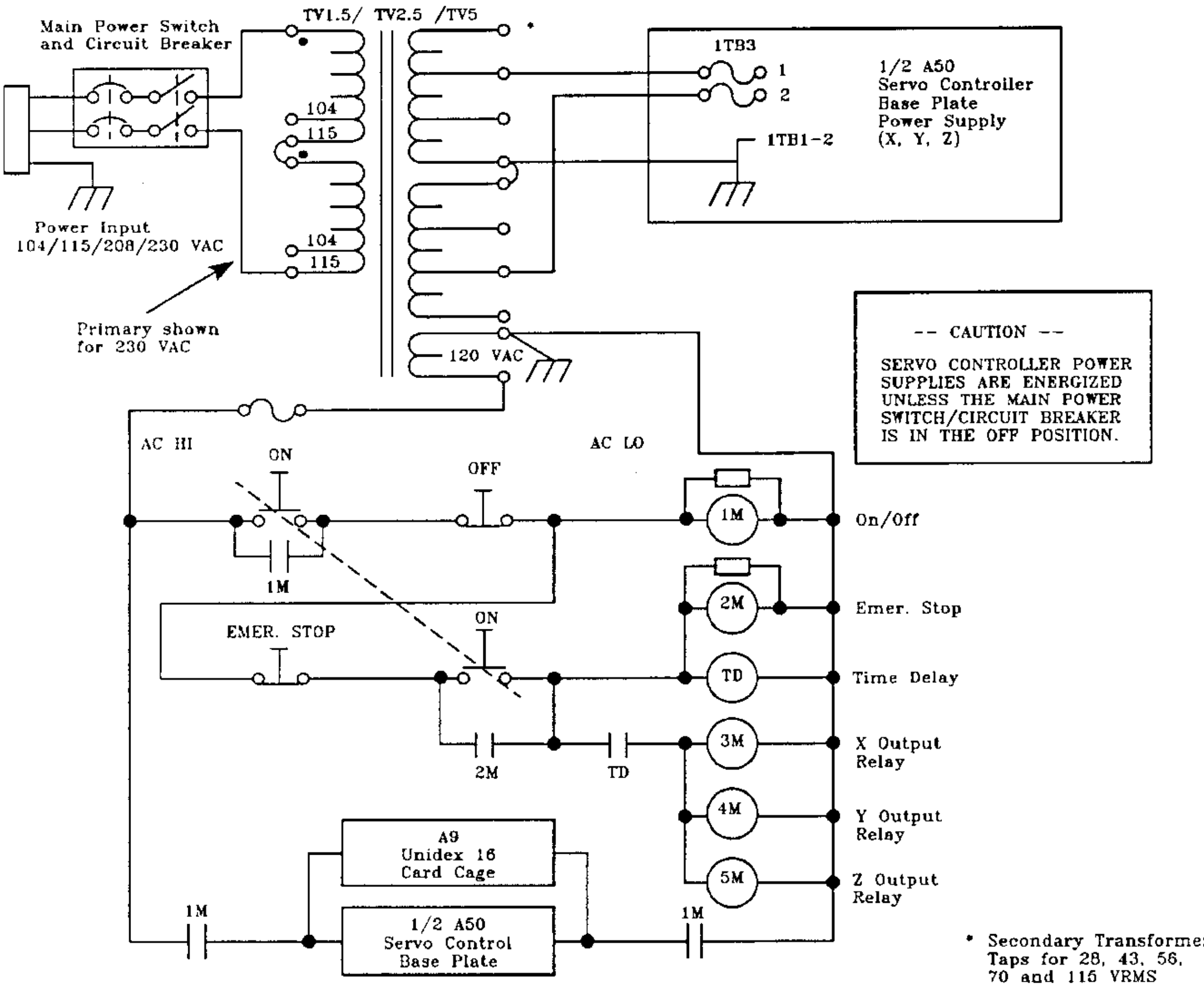



*Figure 3-1: Functional AC Power Wiring for Unidex 16 Systems*

## SECTION 3-3 UNIDEX 16 SYSTEM FUSES

Below is a listing of Unidex 16 system fuses.

| Label | Part Number | Rating | Location | |
|---|---|---|---|---|
| F1 | 313005 | 5ASB | AC Input CPU Drawer or Chassis | |
| F1 | 312020 | 20AFB | Power supply fuse board | +5V |
| F2 | 312003 | 3AFB | Power supply fuse board | +12V |
| F3 | 312002 | 3AFB | Power supply fuse board | -12V |
| F4 | 312001 | 1AFB | Power supply fuse board | +24V |
| F5 | 312001 | 1AFB | Power supply fuse board | -24V |
| F1 | 323010 | 10ASB | Power supply power board AC | |
| F2 | 323010 | 10ASB | Power supply power board AC | |
| F1 | 275003 | 3AFB (PICO) | CRT Board | |
| F1 | 275003 | 3AFB (PICO) | IDX Board | |
| F1 | 313003 | 3ASB | MTI Board | |
| F1 | 275002 | 2AFB (PICO) | TCIO Board | |
| FI | 275002 | 2AFB (PICO) | Brake Control Board | |
| F1 | FNM-10 | 10AFB | AC Input on power drawer or chassis | |
| FB3 | FNW-30 | 30AFB | 3-Axis base plate AC input | |
| X,Y,Z, F1 | ***** | ***** | Remoted Motor Fuse | |
| F1 | 313003 | 3ASB | Supervisory Board Shunt | |
| F2 | 313001 | 1ASB | Supervisory Board Ac Input | |
| F1 | ***** | ***** | Amplifier Motor | |
| F2 | ***** | ***** | Amplifier Bus (if Applicable) | |

**NOTE:** ***** Fuses are based on characteristics of motor or amplifier used in the Unidex system. Refer to applicable motor specification sheets or amplifier/baseplate manuals. Also see *Fusing and Current Limit,* section 5-3, for standard Aerotech motors fusing.

## SECTION 3-4 GROUNDING

Proper grounding is very important. It insures the safe and proper operation of the equipment. All systems require a safety ground.

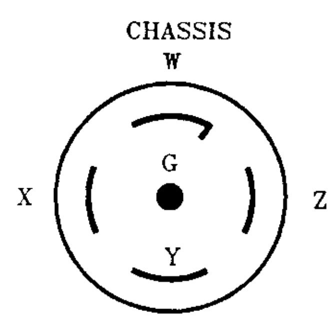
## SECTION 3-5 INPUT POWER CONNECTIONS

The Unidex 16 power wiring is accomplished through one of three methods. They are:

1. Hubbell Flanged Power Inlet Connector (#2815)
2. TRW Terminal Strip (#6-150)
3. Discrete wiring for unpackaged systems

### A. HUBBELL FLANGED POWER INLET CONNECTOR

Following is an illustration of the Hubbell Connector. There are three types of connections which can be made for Unidex 16 input power through this connector.




G Safety Ground
X Line
Y Line
Z Line
W Neutral

2815
Hubbell
Flanged Power
Inlet Connector

## TYPE ONE: 104/115 VAC INPUT DOMESTIC

For 104/115, single-phase AC, 50/60 Hz, 30 amp input power, connect:

| | | |
|---|---|---|
| SAFETY GROUND | TO | G |
| AC LINE HIGH | TO | X |
| AC LINE LOW (NEUTRAL) | TO | W |

## TYPE TWO: 208/230 VAC INPUT DOMESTIC

For 208/230, single-phase AC, 50/60 Hz, 15 amp input power, connect:

| | | |
|---|---|---|
| SAFETY GROUND | TO | G |
| AC LINE | TO | X |
| AC LINE | TO | Y |
| NO CONNECTION | TO | W |

## TYPE THREE: 230 VAC INPUT EUROPEAN

| | | |
|---|---|---|
| SAFETY GROUND | TO | G |
| AC LINE HIGH | TO | X |
| AC LINE LOW (NEUTRAL) | TO | W |

## B. TRW TERMINAL STRIP TB6

The connections required are as follows:

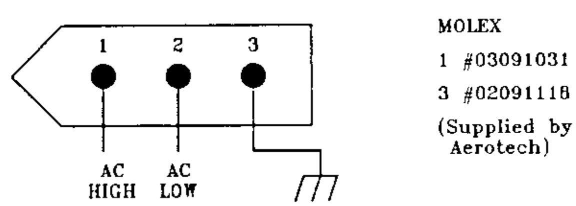
| | |
|---|---|
| SAFETY GROUND | TO FRAME |
| AC LINE | TO TB6-1 |
| AC LINE (OR NEUTRAL) | TO TB6-2 |

Input voltage depends on the transformer wiring.

## C. DISCRETE WIRING FOR UNPACKAGED SYSTEMS

Wiring an unpackaged system is more involved, but figure 3-1 can be used as a guide.

The power wiring to the card cage is through the Molex connector J11, as shown below:




Standard 115 VAC, 2A, 50/60 Hz.
230V input supplied upon special request.

For connections to the servo amplifiers, please refer to the servo amplifier manual.

For more detailed information, please refer to the system drawings or consult the factory.

# CHAPTER 4: LIMIT & HOME SWITCH INTERFACING

If you have been supplied with a complete Unidex 16 system, i.e., controller, cables, motors, encoders, tables, etc., all you must do is plug the correct cables into the appropriate axes.

**NOTE:** Though similar tables may be interchanged, it in not recommended, since each table is calibrated to its own axis.

**CAUTION: NEVER CONNECT OR DISCONNECT ANY CABLE WHILE POWER IS APPLIED.**

The information contained in this chapter defines the Aerotech standard for limit switches and is intended for those customers who are supplying their own stages and/or limit switches.

## SECTION 4-1 LIMIT SWITCH DIRECTION

The terms Clockwise (CW) and Counterclockwise (CCW) refer to motor rotation when viewed from the mounting flange of the motor. This has been adopted as an Aerotech standard to clarify the limits when one controller is interfaced to many different mechanical configurations. Therefore, the CW limit will stop CW rotation and the CCW limit will stop CCW rotation, as illustrated in figure 4-1.

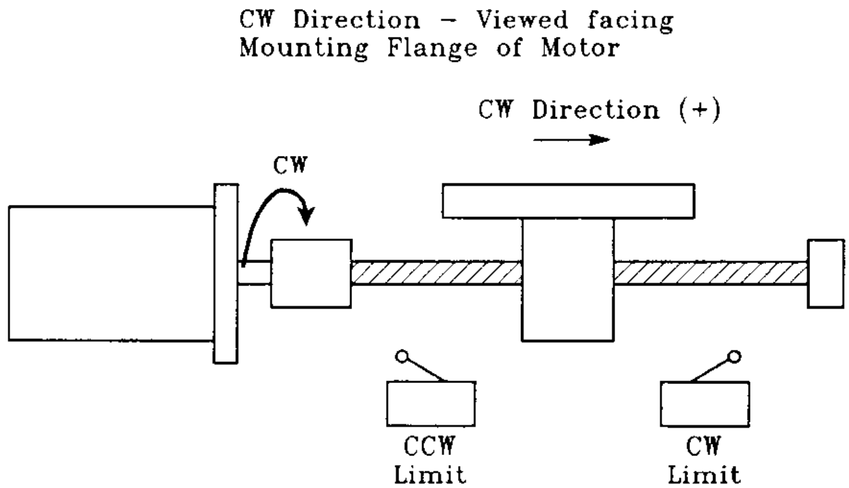



*Figure 4-1: Limit Switch Direction*

On Aerotech tables the electrical limit switches precede the rubber mechanical stops by approximately one revolution of the ballscrew. *Although the rubber mechanical stop will help lighten the blow, it is not recommended that you run the table into it. To do so will result in damage.*

## SECTION 4-2 HOME SWITCH POSITION

Most Aerotech controls come equipped with a cold-starting reference point, which Aerotech calls the Home Position. This is the machine home and is a fixed position, dependent solely on the once-per-revolution marker generated by the rotaty encoders or by the marker that occurs every two inches on the linear encoder.

The purpose of the home switch is to establish which marker will be used as the home reference point. Again, if you have purchased a complete Aerotech system, the home position has already been set up at the factory.

This home reference can be at either end of travel, and if that is the case, you may use the limit switch as your home switch. If, however, some point in between is to be the home reference point, then a separate home switch and a cam are necessary.

**NOTE:** In addition to the hardware considerations, Home CW or Home CCW must be set up in the Unidex 16 EEPROM (parameter #320), where CW is positive (1) and CCW is negative (0). See *Unidex 16 Motion Controller Programming Manual*, chapter 6, for details.

Regardless of whether the home reference point is a CW limit, CCW limit or home switch, its optimum position should be 1/2 revolution (± 1/4 rev) from where the switch opens (for Normally Open type switch) to the leading edge of the marker pulse.

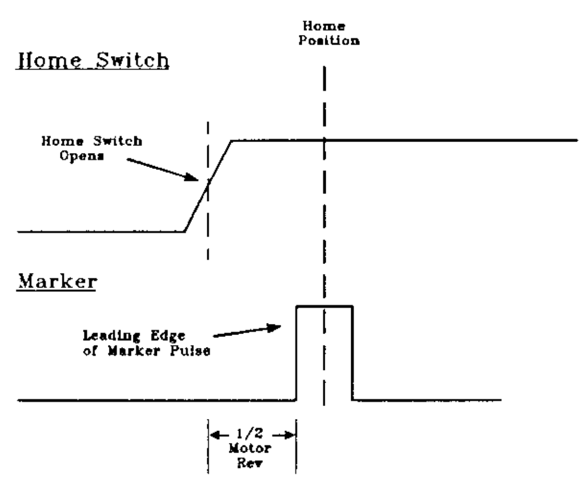



*Figure 4-2: Home Switch Position*

## SECTION 4-3 LIMIT OR HOME INPUTS

A typical home or limit switch input is shown in figure 4-3.

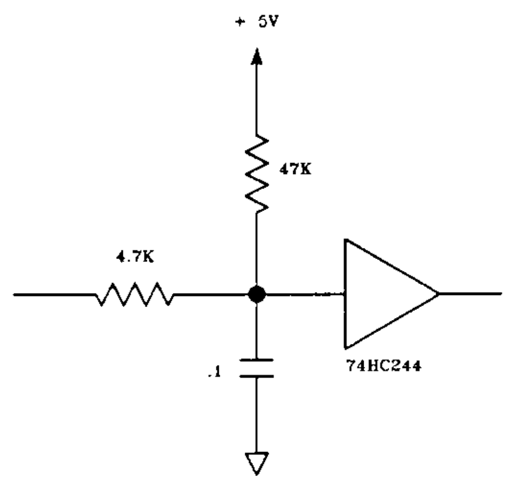


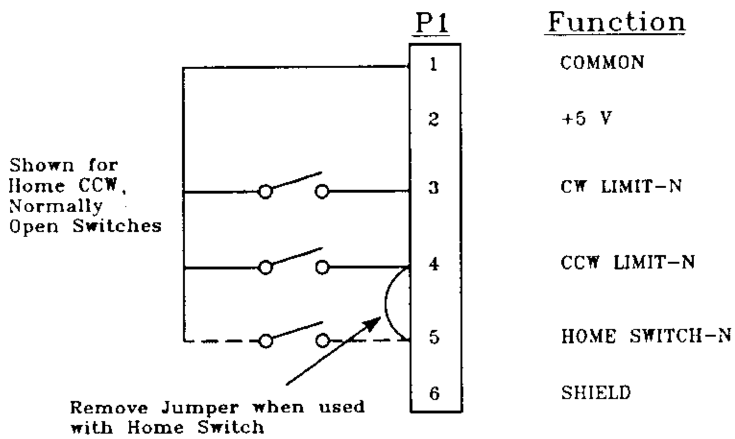

*Figure 4-3: Home or Limit Switch Input*

Figure 4-3 illustrates a 5V CMOS logic input and filter for high noise immunity.

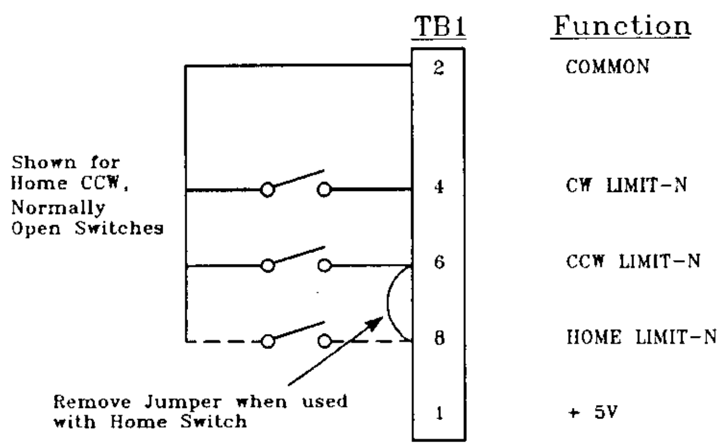
If choosing a mechanical limit switch, it should have a dry circuit contact rating (24V signal or less). The input is normally active when low (logic 0, N.O. switch). However, by changing the appropriate jumper on the Unidex 16 Indexing Board, it can be set up to be active high (logic 1, N.C. switch). (Refer to chapter 7 for details on jumper selections.)

## SECTION 4-4 CONNECTIONS FOR LIMIT & HOME

Connections for the limit and/or home switches are made in one of two places: the terminal board located inside the motor cover or at the J1 circular output connector. These connections are illustrated in figure 4-4 and figure 4-5.




(A) Encoder Terminal Board 690B1207




(B) Encoder Terminal Board 690B1373

*Figure 4-4: Terminal Board Connections*

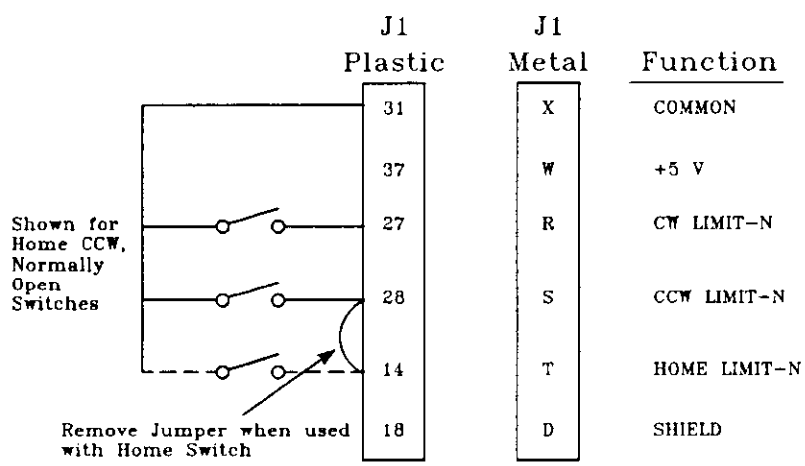



*Figure 4-5: J1 (Metal and Plastic Types) Connections*

The Indexing Board uses a 14 pin Champ plug to receive these signals. The connections are as follows:

| Pin | Function |
|---|---|
| 8 | CW Limit-N |
| 7 | CCW Limit-N |
| 9 | Home Limit-N |
| 1 | Shield |
| 2 | Common |
| 14 | +5 V |

See Indexing Board section of chapter 7 and your system drawing for more details.

For proper system operation, it is critical that the appropriate type of cables are used to connect the motors and indexing board. A 15 conductor, #22 shielded cable (Alpha #5199-15) should be used. Lengths of up to 50 feet are acceptable, if using Aerotech encoders. For longer lengths, or if using non-Aerotech encoders, consult Aerotech.

# CHAPTER 5: MOTOR/TACH INTERFACING

If you have been supplied with a complete Unidex 16 system, i.e., controller, cables, motors, encoders, tables, etc., all you must do is plug the correct cables into the appropriate axes.

The information contained in this chapter is intended for those customers who are supplying their own motor and tachometer. It may also be helpful when servicing the equipment.

## SECTION 5-1 MOTOR/TACH PHASING

The servo drive system can be broken into two parts: the position loop (discussed in chapter 6) and the rate loop (discussed here). The rate loop is made up of the amplifier, the motor and the tachometer.

The amplifier's output commands the motor to turn. The turning of the motor causes the tach to turn and therefore generate a feedback voltage. This feedback voltage has an amplitude which is proportional to speed and a polarity which represents direction. It is important to be certain that the motor and tach polarities are correctly connected to the Aerotech equipment.

If not connected properly, instability of the servo drive system and possibly even a runaway condition may result.

The polarity of the motor and tach is in reference to clockwise (CW) rotation of the motor. This can easily be determined by:

1. Placing a voltmeter's leads on the motor terminals (or leads) and rotating the motor CW. If the leads are connected properly, you should see positive deflection. (CW rotation is always as viewed from the mounting flange of the motor.)

2. Placing the voltmeter leads on the tachometer terminals (or leads) and following the same procedure.

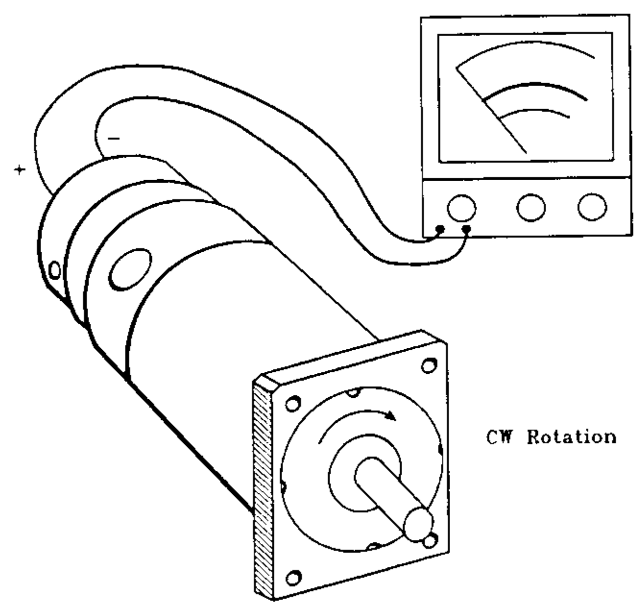



*Figure 5-1: Motor and Tach Phasing*

## SECTION 5-2 CONNECTIONS

Once the polarity of the motor and tach is determined, they should be connected to your Aerotech equipment as shown below. (For other configurations, see your system drawings.)

| Aerotech Motor Color Code | J1 Plastic | J1 Metal | Function |
|---|---|---|---|
| Blue | 29 | Y | Tach + |
| White | 34 | Z | Tach - |
| Red * | 16 | J | Motor + |
| Red * | 6 | P | Motor + |
| Black * | 10 | V | Motor - |
| Black * | 17 | Q | Motor - |

* Multiple output pins are available for higher current applications.

**NOTE:** J1 (MO) is the plastic connector. J1 (MSO) is the metal (military style) connector.

## SECTION 5-3 FUSING AND CURRENT LIMIT

The fusing and the current limit are provided to protect the motor from overheating and the damage that may be caused by excessive peak current conditions.

The motor fuse (located on the servo controller) will protect the motor from overheating. Its rating is determined by the continuous current rating or torque rating of the motor.

The current limit adjustment on the servo controller is determined by the peak torque or peak current rating of the motor. In addition, some of the Aerotech servo controllers have a dynamic current limit adjustment which will limit current with respect to speed for added performance. The following is a list of some of the Aerotech standard motors and windings.

| Motor | Fusing | Current Limit | Dynamic Current Limit |
|---|---|---|---|
| 1017-01 | 4ASB | 16A | Not Applicable |
| 1035-01 | 4ASB | 16A | Not Applicable |
| 1050-01 | 5ASB | 20A | Not Applicable |
| 1075-01 | 5ASB | 20A | 17A @ 4KRPM |
| 1135-01 | 5ASB | 20A | 16A @ 3.5KRPM |
| 1210-01 | 5ASB | 20A | 18A @ 2.5KRPM |
| 1410-03 | 8ASB | 30A | 22A @ 2KRPM |
| 1580-02 | 8ASB | 30A | 26A @ 2KRPM |
| 1960-02 | 12ASB | 30A | NA (35A @ 2KRPM) |

**NOTE1:** This information applies only to the standard windings and may vary on some applications.

**NOTE2:** The above information may also vary with servo amplifier limitations.

**NOTE3:** When a remote motor fuse is provided, the amplifier motor fuse will be ≥ 150% of the remote motor fuse.

# CHAPTER 6: ENCODER INTERFACING

If you have been supplied with a complete Unidex 16 system, i.e., controller, cables, motors, encoders, tables, etc., all you must do is plug the correct cables into the appropriate axes.

The information contained in this chapter is intended not only for those customers who are supplying their own encoders, but for those who want a better understanding of the encoder interface as well.

## SECTION 6-1 POSITION LOOP

As mentioned in chapter 5, the servo drive system can be broken into two parts: the rate loop (discussed in chapter 5) and the position loop which will be covered in this chapter.

The position loop consists of the Unidex 16 indexing board, power amplifier, motor, tachometer and incremental optical encoder.

The position loop is closed around (and is phased with respect to) the rate loop. Therefore, it is important to have a stable rate loop prior to closing the position loop.

The encoder inputs are designed to accept sine, cosine and marker, as well as their complementary signals.

As their names imply, sine and cosine are two signals in quadrature, i.e., when the motor is turning in a clockwise (CW) direction, the cosine signal will lead the sine signal by 90 electrical degrees.

The phase relationship between sine and cosine indicates the direction that the encoder is rotating,and the number of cycles indicates how far the axis has moved. In addition, the resolution can be multiplied by 1, 2, or 4 by selecting the appropriate jumper (see chapter 7) on the Unidex 16 indexing board.

## SECTION 6-2 INPUT CIRCUITRY

The input circuitry is compatible with most sine wave and square wave encoders. A typical input is shown in figure 6-1.

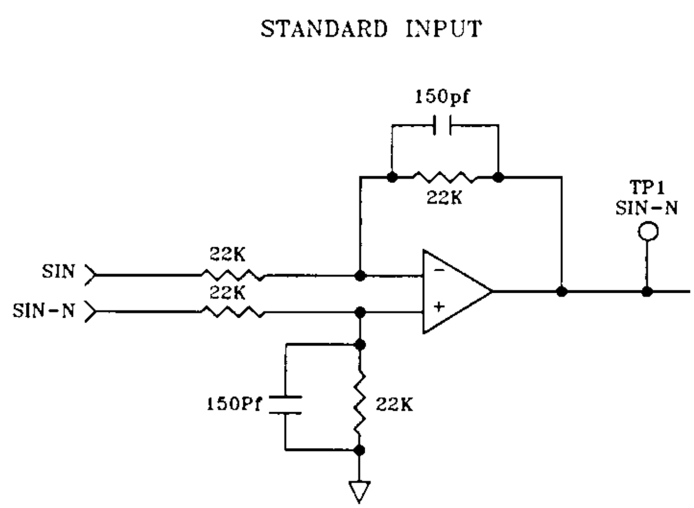



*Figure 6-1: Typical Input - Sine Wave Encoder Board 690C1333*

As shown in the following illustration (figure 6-2), the input signals for the sine wave encoder are both 2 V peak to peak, riding a 2V bias.

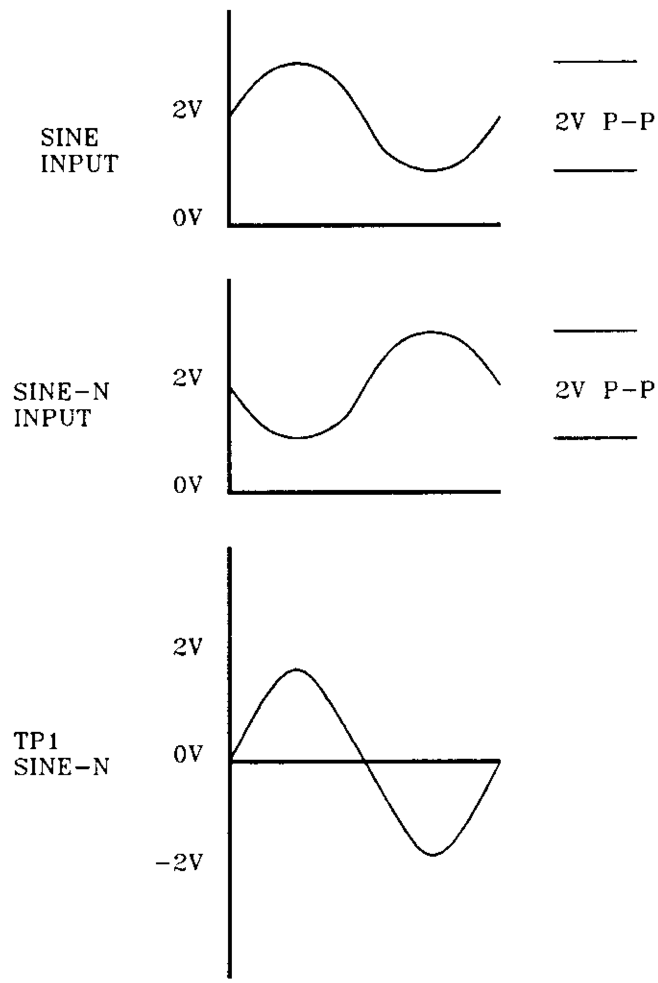



*Figure 6-2: Input Signals for the Sine Wave Encoder using Sine Wave Encoder Bd. 690C1333*

Figure 6-3 shows an example of square wave encoder signals.

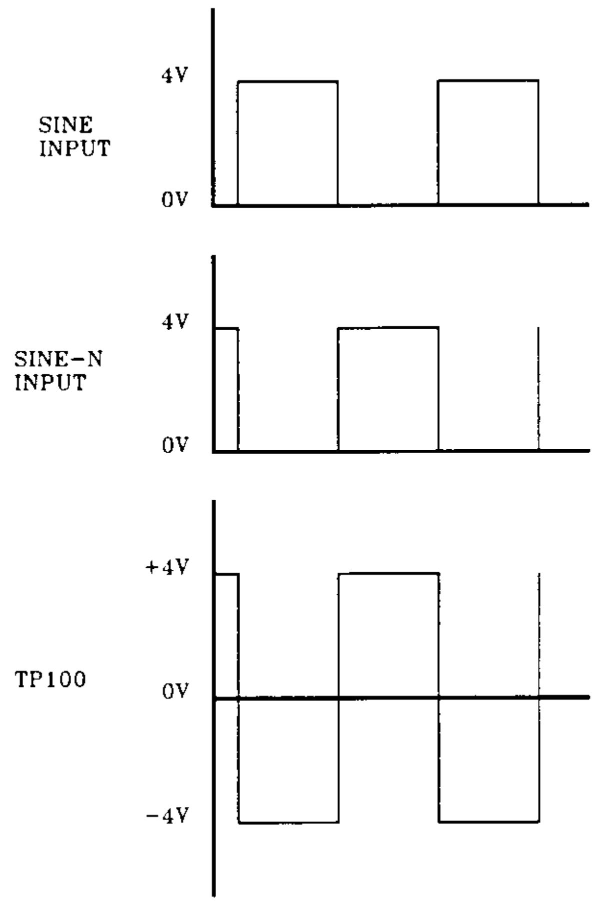



*Figure 6-3: Input Signals for the Square Wave Encoder using Sine Wave Encoder Bd. 690C1333*

Maximum input frequency, in either case, should not exceed 40KHz. (For higher data rates, please consult the factory.)

Whenever single-ended encoders are used, the unused input should be biased at the appropriate voltage (normally 2 volts). For high noise immunity, we advise the use of an encoder with complementary outputs with totem pole drivers. Encoder wires should use shielded cable as well.

## A. LINE RECEIVER INPUT OPTION

The Line Receiver Input Option is available if you should utilize either of the following:

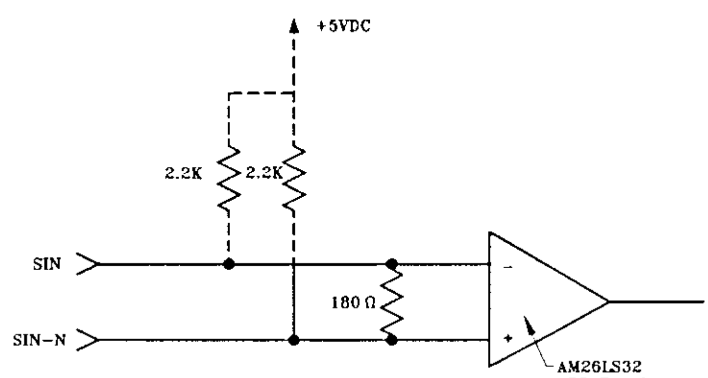
- Encoders with line drivers

- Encoders with TTL outputs that are required to run at high data rates.

When either of the above is the case, the maximum input frequency is 125 KHz.

Line drivers are used in noisy environments and/or when driving long cables.

The TTL output is used when higher data rates are required.




Line Receiver Input (Optional)
Square Wave Encoder Board 690C1334

**NOTE:** A configuration of a line driver is shown in the previous illustration. For TTL output, remove the 180 ohm resistor and connect the two 2.2K pull-up resistors.

## SECTION 6-3 ENCODER PHASING

On Aerotech motor/encoder assemblies, the rotary encoder is mounted on the rear of the motor.

For both rotary and linear encoders, the phasing is as follows: as the motor turns CW, the leading signal is the cosine signal, the trailing signal is the sine signal, and the marker signal coincides with the positive cosine signal. (CW rotation is as viewed from the mounting flange of the motor.)

It should be noted that if a standard Aerotech encoder is mounted at the opposite end of the ballscrew, the shaft rotation will now be reversed and the sine and sine-n signals must be exchanged in order to have proper phasing.

**CAUTION: IMPROPER POSITION LOOP PHASING WILL CAUSE A RUNAWAY CONDITION!**

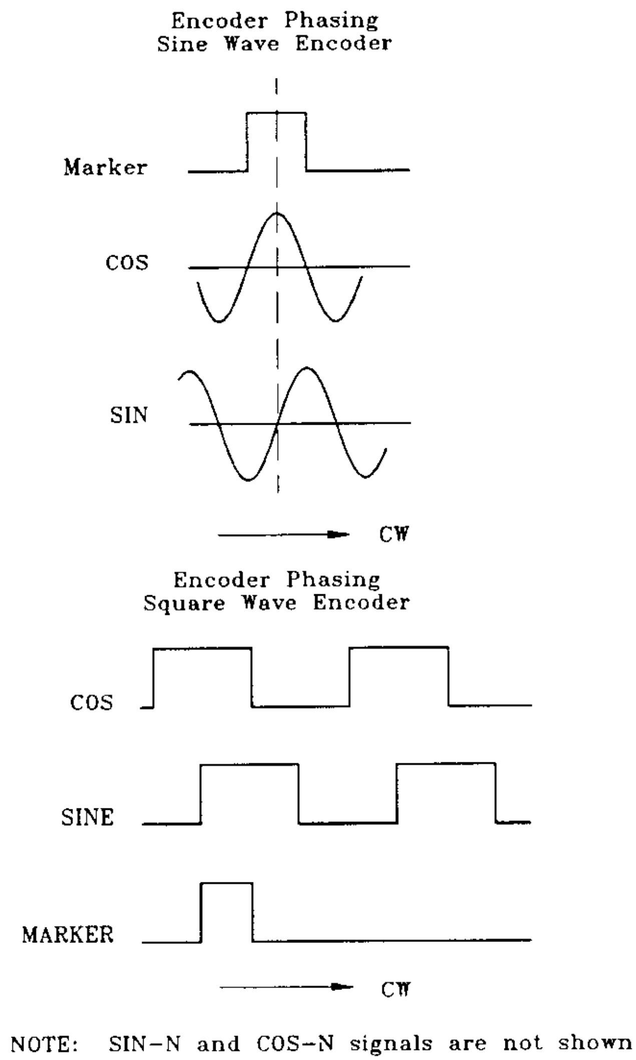



*Figure 6-4: Sine and Square Wave Encoder Phasing*

## SECTION 6-4 PHASING TEST

In figure 6-5, a typical block diagram of the position loop and rate loop is shown.

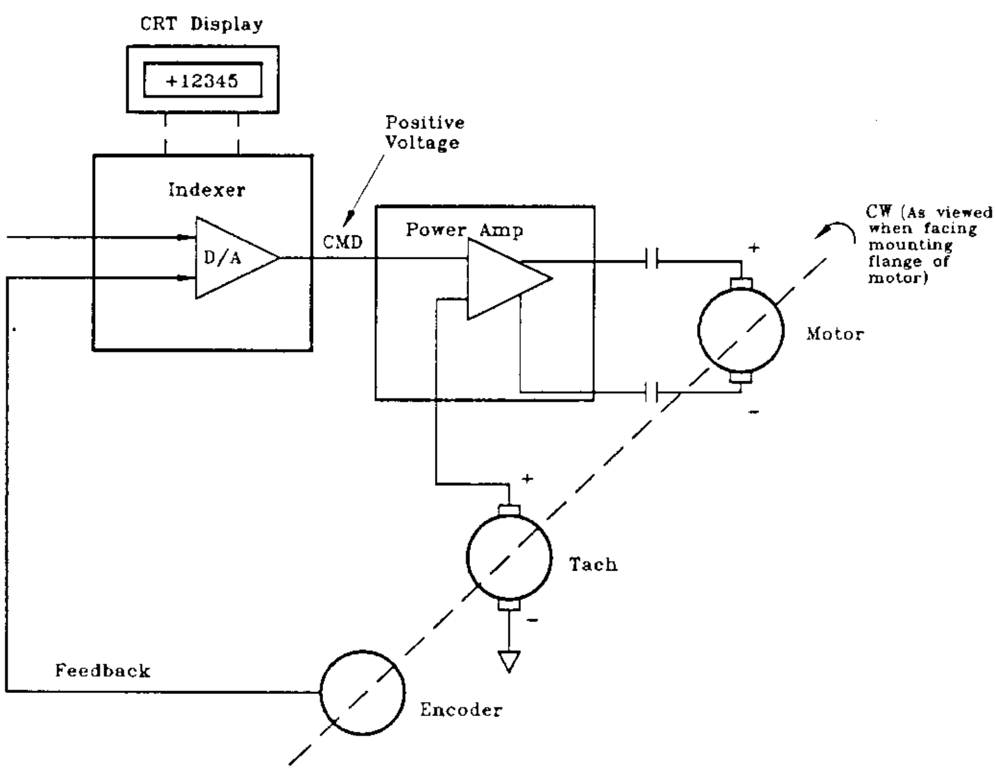



*Figure 6-5: Block Diagram of Position Loop and Rate Loop*

A convenient test for proper system phasing can be accomplished with the following steps:

1. Press the Emergency Stop on Unidex 16 in order to disable the drives.

2. Manually rotate the motor shaft CW.

3. Observe tracking displays for positive count for standard system direction. (See chapter 7 of this manual for jumper selections and chapter 6 of the *Unidex 16 Motion Controller Programming Manual* for parameter selections, both pertaining to system direction.)

4. With a voltmeter, measure the following:
   a) A positive voltage should be measured from signal common to the tach input.
   b) A positive voltage should be measured from signal common to the command input.

5. Motor phasing can be checked across the motor or at the motor input to Unidex 16 (see chapter 5, Motor/Tach Phasing).

## SECTION 6-5 CONNECTIONS

The encoder connections to be discussed in this section pertain to most Unidex 16 systems. However, if you have any questions concerning your system, refer to your system drawings.

There are four sites where the standard encoder connections can be made:

1. Encoder terminal board

2. J1 plastic (Amp #206151-1) connector
3. J1 metal (MS #3106A-24-28P) connector
4. J3/4/5 IDX Board (Amp 55236-1)

Below are listed the standard encoder interface connections.

| Functions | IDX Board J3/J4/J5 | J1 Metal Connector | J1 Plastic Connector | 690B1207 Terminal Board | 690B1373 Terminal Board |
|---|---|---|---|---|---|
| Sine | 11 | F | 26 | 7 | A |
| Sine-N | 4 | L | 20 | 8 | B |
| Cosine | 10 | E | 25 | 5 | C |
| Cosine-N | 3 | K | 19 | 6 | D |
| Marker | 12 | G | 21 | 4 | E |
| Marker-N | 5 | M | 22 | 3 | F |
| +5V | 14 | A | 35 | 2 | G |
| Common | 2 | B | 32 | 1 | H |
| Shield | 1 | C | 30 | N.C. | N.C. |

The Indexing Board uses a 14 pin Champ Plug (Amp 55236-1) to receive these signals.

For proper system operation, it is critical that the appropriate type of cables are used to connect the motors and indexing board.

A 15 conductor; #22 shielded cable (Alpha #5199-15) should be used. Lengths of up to 50 feet are acceptable if using Aerotech encoders. For longer lengths, or if using non-Aerotech encoders, consult Aerotech.

# CHAPTER 7: MODULE JUMPERS & CONNECTORS

## SECTION 7-1 CARD CAGE JUMPERS AND SWITCHES

### A. COMMON/FRAME GROUND JUMPERS

**Standard Configuration:**

R1 = 100 Ohms, 1/2 Watt resistor
R2 = 0 Ohm jumper

R1 and R2 connect Unidex 16 DC Power Supply Common to the Card Cage Frame. To isolate the power supply common from the card cage frame, remove R1 and R2 as required.

### B. FAULT SWITCH

The fault circuit is a fail safe circuit that the Unidex 16 uses to protect the system. The circuit will report a fault if it is opened and the Unidex 16 will assert the shutdown line. The fault circuit is daisy chained through all of the card slots (A1 - A8) of the card cage, and may be connected to external equipment by using the fault input and output connections.

Because the fault circuit runs through circuit boards in the card cage, switches are provided on the mother board to route the circuit through boards which are active in the system and to bypass unused card slots. The following table lists the switch settings to be used for the eight card slot positions.

| ASSEMBLY# | SLOT | MODULE | SWITCH | ACTIVE | BYPASSED |
|---|---|---|---|---|---|
| A1 | S0 | PWR.SUPPLY 690E1254 | NO SWITCH | N/A | N/A |
| A2 | S1 | CPU BD. 690D1255 | NO SWITCH | N/A | N/A |
| A3 | S2 | CRT BD. 690D1256 | SW7-1 | OFF | ON |
| A4* | S3 | FDC BD. 690D1258 | SW7-2 | OFF | ON |
| A5* | S4 | MEM BD. 690D1257 | SW8-1 | OFF | ON |
| A6* | S5 | MEM BD. 690D1257 | SW8-2 | OFF | ON |
| A7* | S6 | IDX BD. 690D1261 | SW9-2 | OFF | ON |
| A8 | S7 | IDX BD. 690D1261 | NO SWITCH | N/A | N/A |

* Indicates optional module

For example, if the optional Indexing Board A7 is not used, switch SW9-2 must be in the "ON" position and if it is used, it must be in the "OFF" position.

**NOTE:** The optional Laser Firing, Binary Output and Axis Free Run Cards do not use the fault circuit. If these cards are in the system, the slots used by them must be bypassed.

## C. ACKNOWLEDGE SWITCH

The acknowledge signal is an interlocking signal that is daisy chained through all of the card slots (A1 - A8) of the card cage. Similar to the fault circuit, switches are provided on the mother board to route the circuit through boards which are active in the system and to bypass unused card slots. Incorrect settings will cause a bus error. The following table lists the switch settings to be used for the eight card slot positions.

| ASSEMBLY# | SLOT | MODULE | SWITCH | ACTIVE | BYPASSED |
|---|---|---|---|---|---|
| A1 | S0 | PWR.SUPPLY 690E1254 | NO SWITCH | N/A | N/A |
| A2 | S1 | CPU BD. 690D1255 | NO SWITCH | N/A | N/A |
| A3 | S2 | CRT BD. 690D1256 | SW1-1 | OFF | ON |
| A4* | S3 | FDC BD. 690D1258 | SW2-1 | OFF | ON |
| A5* | S4 | MEM BD. 690D1257 | SW3-1 | OFF | ON |
| A6* | S5 | MEM BD. 690D1257 | SW4-1 | OFF | ON |
| A7* | S6 | IDX BD. 690D1261 | SW5-1 | OFF | ON |
| A8 | S7 | IDX BD. 690D1261 | NO SWITCH | N/A | N/A |

* Indicates optional module

For example:

When Unidex 16 is used without the floppy disk control option (FDC A4), the bypass switch (SW2-1) must be in the "ON" position and if used with the FDC option, the bypass switch (SW2-1) must be in the "OFF" position.

**NOTE:** The optional Laser Firing, Axis Free Run and Binary Output Cards do not used the Acknowledge circuit. If these cards are in the system, the slots used by them must be bypassed.

## D. REMAINING SWITCHES

The remaining switches are reserved for future use and although they have no effect on Unidex 16 at this time, they should be in the "OFF" position unless otherwise specified.

## E. FAULT INPUT J9-8

The fault input (TTL input) must be pulled low or a fault condition will exist that will inhibit normal system operation. If this input is not used, it can be jumpered to J9-1 (common).

## F. FAULT OUTPUT J9-7

The fault output is normally low (open collector output) and is pulled high when a fault occurs. This output is usually tied to the shutdown input J9-6.

## G. SHUTDOWN INPUT J9-6

The shutdown input J9-6 must be pulled low or a shutdown will occur. This input is normally tied to the fault output J9-7.

**NOTE:** When used with an Aerotech servo controller, the shutdown signal is a 12V logic signal.

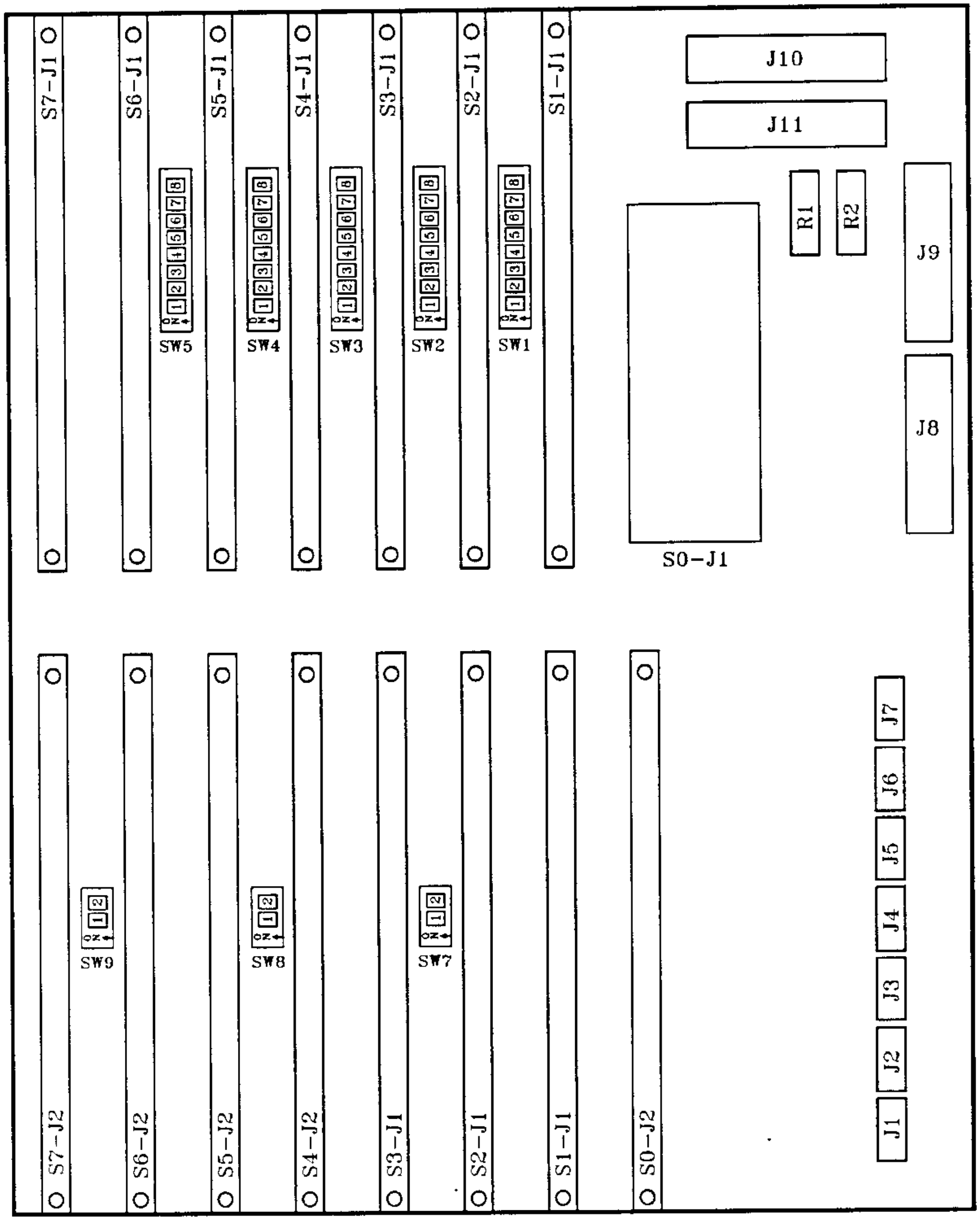



*Figure 7-1: Card Cage Jumper and Switch Locations*

# SECTION 7-2 CPU BOARD JUMPER SELECTIONS

## A. CPU BOARD JUMPERS

### 1. BATTERY BACK-UP JUMPER

**Battery #1**

| **Jumper** | |
|---|---|
| 1-2 | Battery 1 inactive (storage) |
| 1-3 | Battery 1 active |
| 1-4 | External battery (not available) |

**Battery #2**

| **Jumper** | |
|---|---|
| 72-73 | Battery 2 inactive (storage) |
| 72-71 | Battery 2 active |

In order to back up the user memory when control power is turned off, the CPU board is supplied with battery #2 installed. It is activated by jumper 72-71. Battery #1 is omitted, and it is deactivated by jumper 1-2.

When battery #2 runs low (indicated by an error message), a new battery must be installed, following these steps:

1. Insert battery #1
2. Secure with tie wrap
3. Change jumper 1-2 to jumper 1-3
4. Change jumper 72-71 to jumper 72-73
5. Remove battery #2

## 2. EEPROM SIZE JUMPER

| Jumper | |
|---|---|
| 59-60 | * 2816A EEPROM (16K) |
| 60-61 | 2864A EEPROM (64K) |

## 3. RS-232/422 JUMPERS

| Jumper 33-34 | |
|---|---|
| IN | Port-A is configured for RS-422 |
| OUT | * Port-A is configured for RS-232 |

| Jumper 31-32 | |
|---|---|
| IN | Port-B is configured for RS-422 |
| OUT | * Port-B is configured for RS-232 |

## 4. MODEM/TERMINAL JUMPERS

In order to communicate with different types of RS-232/422 devices, there are jumpers provided on the CPU board.

Following is a list of your possible selections if using RS-232.

| Port-a | | Port-b | |
|---|---|---|---|
| Unidex 16 As Terminal | Unidex 16 As Modem | Unidex 16 As Terminal | Unidex 16 As Modem |
| 7-8 | * 8-9 | 35-36 | * 36-37 |
| 10-11 | * 11-12 | 38-39 | * 39-40 |
| 13-14 | * 14-15 | 41-42 | * 42-43 |
| 16-17 | * 17-18 | 44-45 | * 45-46 |
| 19-20 | * 20-21 | 47-48 | * 48-49 |
| 22-23 | * 23-24 | 50-51 | * 51-52 |
| 25-26 | * 26-27 | 53-54 | * 54-55 |
| 28-29 | * 29-30 | 56-57 | * 57-58 |

**NOTE:** In order to achieve the correct results, *all* selections in any of the above columns must be jumpered.

## 5. BUS ERROR JUMPER

**(for Purpose Of Servicing The System Only)**

**Jumper 5-6**

| | |
|---|---|
| IN | * Normal system operation |
| OUT | Servicing system only |

Under normal circumstances, jumper 5-6 is IN and when a bus error is detected the microprocessor services the bus error circuit, displaying the bus error on the CRT.

When the system is to be serviced, the above routine is omitted by removing jumper 5-6. In this case, when a bus error occurs, the microprocessor will halt the bus, waiting for a DTACK-N signal.

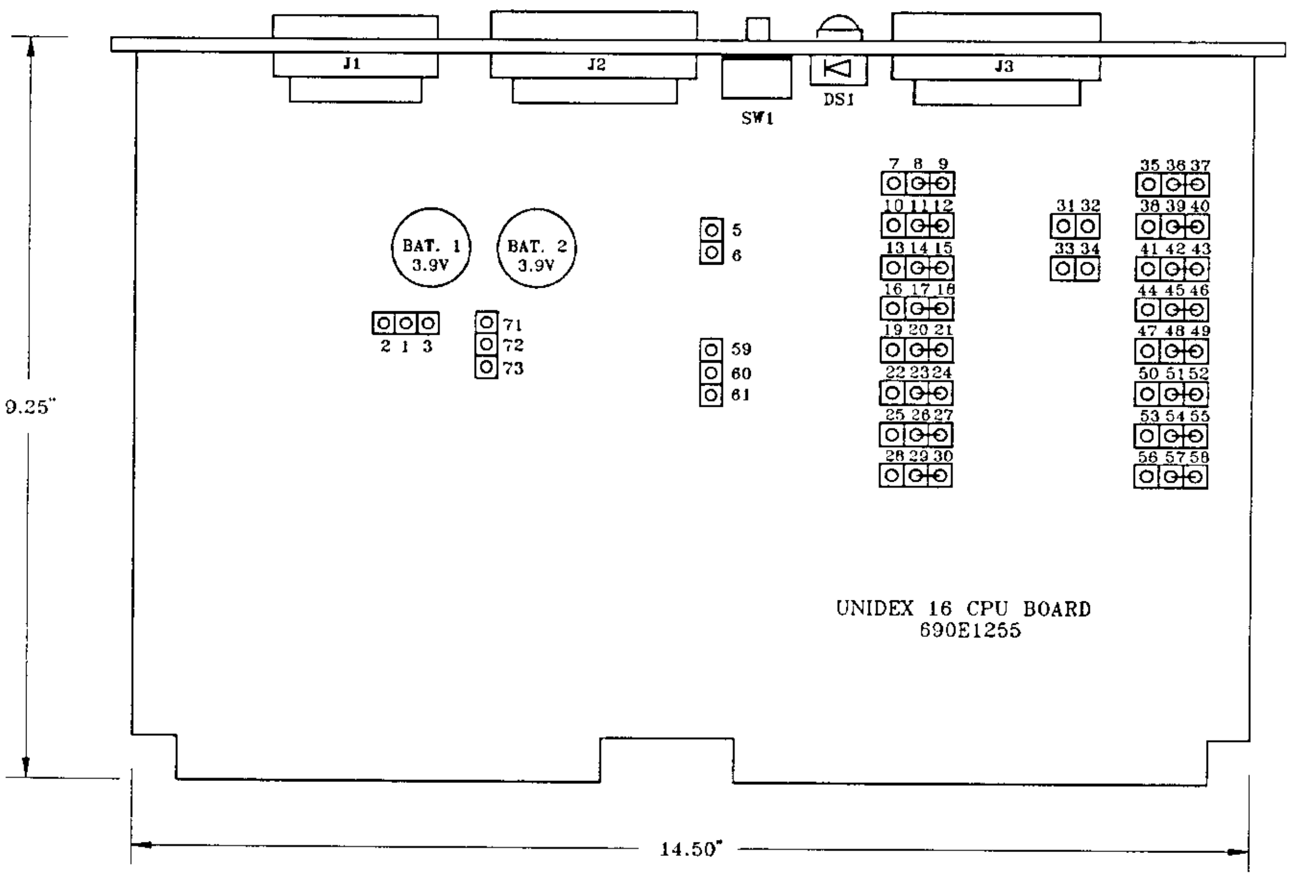



*Figure 7-2: CPU Board*

## B. RS-232/422 COMMUNICATION

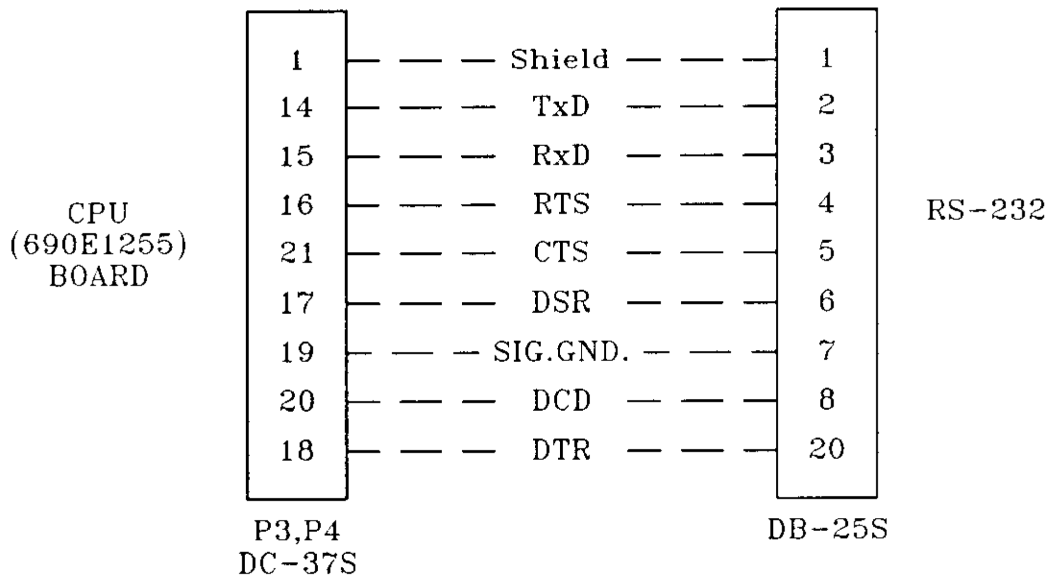
**(for Unpackaged System)**

Though cables for RS-232/422 communications are not supplied, the following diagrams illustrate the necessary connections.

CPU (690E1255) BOARD — RS-422

| P3,P4 DC-37S | Signal | DC-37S |
|---|---|---|
| 1 | Shield | 1 |
| 4 | SD+ | 4 |
| 22 | SD- | 22 |
| 7 | RS+ | 7 |
| 25 | RS- | 25 |
| 12 | TR+ | 12 |
| 30 | TR- | 30 |
| 6 | RD+ | 6 |
| 24 | RD- | 24 |
| 11 | DM+ | 11 |
| 29 | DM- | 29 |
| 9 | CS+ | 9 |
| 27 | CS- | 27 |
| 13 | RR+ | 13 |
| 31 | RR- | 31 |

CPU RS-422 PORT CABLE DIAGRAM




CPU RS-232 PORT CABLE DIAGRAM

## SECTION 7-3 CRT BOARD JUMPERS

Aerotech standards for jumper selections will be indicated with an asterisk (*).

### A. AC CLOCK JUMPER

**(Not available at this time)**

**JP1**

| | |
|---|---|
| IN | Synchronizes monitor with AC line |
| OUT | * Not synchronized |

The AC clock jumper is designated to eliminate the effect of the AC line on the monitor of the CRT board.

## B. COLOR GRAPHICS

**(Not Available At This Time)**

| | |
|---|---|
| **JP2** | |
| IN | * No color graphics |
| **JP3** | |
| IN | * No color graphics |
| **JP4** | |
| IN | * No color graphics |
| **JP5** | |
| 1-2 | * |
| 2-3 | |
| **JP7** | |
| 1-2 | * |
| 2-3 | |

These jumpers represent hardware provisions for future use of color graphics. Though not used at this time, all of these jumpers must be installed.

## C. FAULT

| | |
|---|---|
| **JP6** | |
| 1-2 | * MST bus fault disabled |
| 2-3 | MST bus fault enabled |

## D. REMOTE KEYBOARD

**JP8**

| | |
|---|---|
| 1-2 | * No remote keyboard |
| 2-3 | Remote QWERTY keyboard in use |

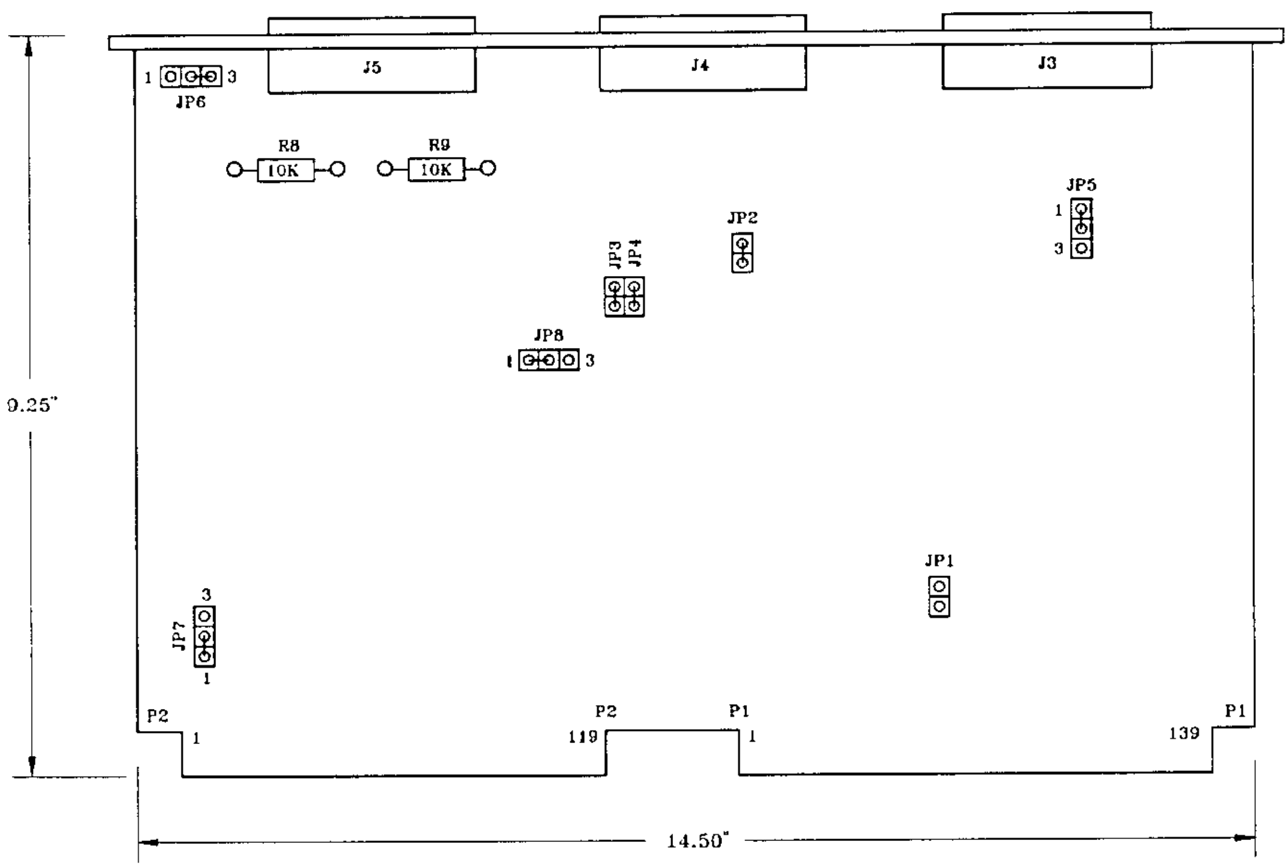



*Figure 7-3: CRT Board*

## SECTION 7-4 IDX BOARD JUMPERS & CONNECTORS

Aerotech standards for jumper selections will be indicated with an asterisk (*).

The silk screen on the indexing board is for the XYZ axes group. Therefore, if the indexing board is addressed for UVW operation, a silkscreened X indicates the U axis, a Y indicates the V axis, and a Z indicates the W axis.

### A. AXIS ADDRESS JUMPERS

| | | JP4 | JP5 |
|---|---|---|---|
| * A8 | X,Y,Z | 1-2 | IN |
| A7 | U,V,W | 2-3 | OUT |

To address the indexing board for X, Y, Z operation (A8), jumper JP4 1-2, JP5 IN.

To address the indexing board for U, V, W operation (A7), jumper JP4 2-3, JP5 OUT.

### B. LIMIT JUMPERS

| | XJP1 | YJP1 | ZJP1 |
|---|---|---|---|
| * Normally Open (LMT-N) | OUT | OUT | OUT |
| Normally Closed (LMT) | IN | IN | IN |

| SPARE | XJP2 | YJP2 | ZJP2 |
|---|---|---|---|
| * | IN | IN | IN |

For LMT-N, a low signal indicates a limit. For LMT, a high signal indicates a limit.

**NOTE:** CW/CCW rotation refers to motor shaft rotation viewed from mounting flange end of motor.

## C. RESOLUTION JUMPERS

Position feedback can be multiplied by a factor of 1, 2 or 4. For example: a 1000 line encoder multiplied by a factor of 4 gives 4000 line/revolution (X4 resolution).

### 1. XI RESOLUTION

**Main Indexing Board 690D1261 (For Sine Wave And Square Wave Encoders)**

| | | | |
|---|---|---|---|
| XJP4 | YJP4 | ZJP4 | 1-2 |
| XJP5 | YJP5 | ZJP5 | 1-2 |
| XJP6 | YJP6 | ZJP6 | OUT |
| XJP7 | YJP7 | ZJP7 | OUT |

**X/Y/Z Sine Wave Encoder Board 690C1333 (For Sine Wave Encoder Only)**

| | |
|---|---|
| R5 | 22K |
| R6 | OUT |
| R7 | OUT |
| R8 | 43K |

*JUMPER 2-3 (REMOVE 1-2)*

### 2. X2 RESOLUTION

**Main Indexing Board 690D1261 (For Sine Wave & Square Wave Encoders).**

| | | | |
|---|---|---|---|
| XJP4 | YJP4 | ZJP4 | 1-2 |
| XJP5 | YJP5 | ZJP5 | 1-2 |
| XJP6 | YJP6 | ZJP6 | OUT |
| XJP7 | YJP7 | ZJP7 | IN |

**X/Y/Z Sine Wave Encoder Board 690C1333 (For Sine Wave Encoder Only)**

| | |
|---|---|
| R5 | 22K |
| R6 | OUT |
| R7 | OUT |
| R8 | 43K |

*JUMPER 2-3 (REMOVE 1-2)*

## * 3. X4 RESOLUTION

**Main Indexing Board 690D1261 (For Sine Wave And Square Wave Encoders)**

| | | | |
|---|---|---|---|
| XJP4 | YJP4 | ZJP4 | 1-2 |
| XJP5 | YJP5 | ZJP5 | OUT |
| XJP6 | YJP6 | ZJP6 | IN |
| XJP7 | YJP7 | ZJP7 | OUT |

*** X/Y/Z Sine Wave Encoder Board 690C1333 (For Sine Wave Encoder Only)**

| | |
|---|---|
| R5 | OUT |
| R6 | 43K |
| R7 | 22K |
| R8 | OUT |

*JUMPER 1-2 (REMOVE 2-3)*

Unless otherwise specified, the X4 resolution mode is the Unidex 16 Indexing Board standard. This standard configuration includes three Sine Wave Encoder Interface Boards (690C1333), which are plugged into the main Indexing Board. If a square wave encoder is required, the sine wave interface must be removed and replaced with a Square Wave Encoder Interface Board (690C1334). These Encoder Interface Modules can be mixed and matched.

## D. DIRECTION JUMPERS

| | JP1 | | JP2 | | JP3 |
|---|---|---|---|---|---|
| * +X=CW | OUT | * +Y=CW | OUT | * +Z=CW | OUT |
| +X=CCW | IN | +Y=CCW | IN | +Z=CCW | IN |

CW/CCW rotation refers to motor shaft rotation when viewed from mounting flange end of motor.

When direction becomes inverted, all travel relating to an axis gets inverted as well. (Refer to Home Direction Parameter #320 and Jog Arrows Parameter #160.)

## E. FEEDBACK CL/COM CL OUTPUT SELECT JUMPER

Select jumper according to whether feedback clock or command clock is to be output to 10-pin connector interface A9J1-A9J6.

| | XJP8 | XJP9 | YJP8 | YJP9 | ZJP8 | ZJP9 |
|---|---|---|---|---|---|---|
| * Feedback Cl | 1-2 | 1-2 | 1-2 | 1-2 | 1-2 | 1-2 |
| Command Cl | 2-3 | 2-3 | 2-3 | 2-3 | 2-3 | 2-3 |

## F. COUNT ZERO DEAD BAND JUMPER

| | XJP10 | YJP10 | ZJP10 |
|---|---|---|---|
| * 3 BIT | IN | IN | IN |
| 5 BIT | OUT | OUT | OUT |

Designates if dead band range is 3 bits or 5 bits.

## G. D/A RESOLUTION JUMPER

| | XJP11 | YJP11 | ZJP11 |
|---|---|---|---|
| * 2048 BITS | 1-2 | 1-2 | 1-2 |
| 1024 BITS | 2-3 | 2-3 | 2-3 |

2048 Bits give ±2048 range on D/A, or 4.9mV per bit resolution.
1024 Bits give ±1024 range on D/A, or 9.8mV per bit resolution.

## H. ACCEL/DECEL RATE OFFSET JUMPERS

| | JP7 | JP8 | JP9 | JP10 | JP11 |
|---|---|---|---|---|---|
| ** MIN. RATE OFFSET* | IN | IN | IN | IN | IN |
| | IN | IN | IN | IN | OUT |
| | IN | IN | IN | OUT | IN |
| | IN | IN | IN | OUT | OUT |
| | . | . | etc. | . | . |
| *MAX. RATE OFFSET* | OUT | OUT | OUT | OUT | OUT |
| | **MSB** | | | | **LSB** |

## I. ENCODER FAULT JUMPER

Add jumpers as required to disable the fail-safe encoder fault circuit on any axis not in use.

| JUMPER | XJP3 | YJP3 | ZJP3 |
|---|---|---|---|
| * Enable | 2-3 | 2-3 | 2-3 |
| Disable | 1-2 | 1-2 | 1-2 |

For example:

When using a 3-axis indexing board (IDX-3) for a 2-axis system in the XY configuration, the jumper from 1-2 on ZJP3 must be installed in order to disable the drive fault condition. If not, system operation will be inhibited.

## J. USER FREE-RUN (SFR) OPTION

With this option you can select the speed of the free-run axis via "S" commands and run/stop via "M" commands. Only one of the axes in your system can be configured for axis free-run. In addition to adding the User Free-Run Board (690D1303) to the Unidex 16 card cage, the following hardware changes must be made to the indexing board. (See chapter 13 of the *Unidex 16 Motion Controller Programming Manual* for more information.) The User Free-Run option cannot be used with the Encoder Sync option.

| | FREE RUN AXIS | | | |
|---|---|---|---|---|
| JUMPER | X | Y | Z | NO FREE-RUN* |
| XJP13 | OUT | 1-2 | 1-2 | 1-2 |
| XJP14 | OUT | 1-2 | 1-2 | 1-2 |
| YJP13 | 1-2 | OUT | 1-2 | 1-2 |
| YJP14 | 1-2 | OUT | 1-2 | 1-2 |
| ZJP13 | 1-2 | 1-2 | OUT | 1-2 |
| ZJP14 | 1-2 | 1-2 | OUT | 1-2 |
| XJP16 | 1-2 | 2-3 | 2-3 | 2-3 |
| XJP17 | 1-2 | 2-3 | 2-3 | 2-3 |
| XJP18 | 1-2 | 2-3 | 2-3 | 2-3 |
| YJP16 | 2-3 | 1-2 | 2-3 | 2-3 |
| YJP17 | 2-3 | 1-2 | 2-3 | 2-3 |
| YJP18 | 2-3 | 1-2 | 2-3 | 2-3 |
| ZJP16 | 2-3 | 2-3 | 1-2 | 2-3 |
| ZJP17 | 2-3 | 2-3 | 1-2 | 2-3 |
| ZJP18 | 2-3 | 2-3 | 1-2 | 2-3 |
| JP18 | 1-4 | 1-3 | 1-2 | 1-5 |
| JP19 | 1-4 | 1-3 | 1-2 | 1-5 |
| JP20 | 1-2 | 1-3 | 1-4 | 1-5 |

## K. ENCODER SYNCHRONIZATION (E SYNC) OPTION

The Encoder Synchronization Option is used to synchronize Unidex 16 with other equipment (such as a conveyor belt) for the purpose of positioning or contouring on the fly. Only one of the axes within your system can be configured for E Sync. In addition to adding an Encoder Synchronization Board to your system, the following jumper changes must be made to the proper axis. For more information on Encoder Synchronization, see the *Unidex 16 Motion Controller Programming Manual*, chapter 13. The Encoder Sync cannot be used with the User Free-run option.

**E SYNC AXIS**

| Jumper | X | Y | Z | No E Sync * |
|---|---|---|---|---|
| XJP13 | 1-3,2-4 | 1-2 | 1-2 | 1-2 |
| XJP14 | 1-3,2-4 | 1-2 | 1-2 | 1-2 |
| XJP15 | 1-3,2-4 | 1-2 | 1-2 | 1-2 |
| YJP13 | 1-2 | 1-3,2-4 | 1-2 | 1-2 |
| YJP14 | 1-2 | 1-3,2-4 | 1-2 | 1-2 |
| YJP15 | 1-2 | 1-3,2-4 | 1-2 | 1-2 |
| ZJP13 | 1-2 | 1-2 | 1-3,2-4 | 1-2 |
| ZJP14 | 1-2 | 1-2 | 1-3,2-4 | 1-2 |
| ZJP15 | 1-2 | 1-2 | 1-3,2-4 | 1-2 |

## L. AEROTECH RESERVED JUMPER

Jumper J12 is reserved for Aerotech use and should be jumpered 1-2.

## M. MARKER INPUT

There are 3 resistors per axis which vary according to the type of marker input signal used. These may vary in value or not be used at all. The following table shows the possible combinations.

| AXIS | | | INPUT TYPE | | |
|---|---|---|---|---|---|
| X/U | Y/V | Z/W | Sine Wave (Analog) | TTL | Line Receiver |
| R100/ | R200/ | R300 | out | 2.2K | out |
| R101/ | R201/ | R301 | out | 2.2K | out |
| R102/ | R202/ | R302 | out | out | 180 ohms |
| | *Resistors* | | | *Values* | |

The board is normally supplied set up for sine wave input (no resistors).

## N. INDEXING BOARD CONNECTORS

### 1. CONNECTORS J1 AND J2

Unidex 16 Versabus card edge connectors require no customer interfacing.

### 2. CONNECTORS J3, J4, J5 (XYZ/UVW)

**Encoder, Limit And Tach Interface:**

| PIN # | FUNCTION | COMMENT |
|---|---|---|
| 1 | SIGNAL SHIELD | |
| 11 | SIN | For more information |
| 4 | SIN-N | on encoder inputs, |
| 10 | COS | see chapter 6 of |
| 3 | COS-N | this manual. |
| 12 | MARKER | |
| 5 | MARKER-N | |
| | | |
| 14 | +5V OUTPUT | 250 mA per axis, |
| 2 | COMMON | maximum. |
| | | |
| 8 | CW/CW-N LIMIT | For more information |
| 7 | CCW/CCW-N LIMIT | on limit inputs, |
| 9 | HOME/HOME-N LIMIT | see chapter 4. |
| | | |
| 13 | RESERVED | |
| 6 | RESERVED | |

**Mating Connector:**

| | **Aerotech Number** |
|---|---|
| 3M CONNECTOR 3572-1001 | (ECK 354) |
| **or** | |
| AMP CONNECTOR 552316-1 | (ECK 357) |
| BACKSHELL 2-552412-1 | (ECK 366) |

## 3. CONNECTOR J6, SERVO AMPLIFIER INTERFACE (XYZ/UVW)

| PIN # | FUNCTION | COMMENT |
|---|---|---|
| 1 | SIGNAL SHIELD | |
| 28 | X/U OUTPUT | ± 10V Analog Output |
| 34 | Y/V OUTPUT | |
| 40 | Z/W OUTPUT | |
| 3 | X/U COMMON | |
| 2 | X/U COMMON | |
| 9 | Y/V COMMON | Analog Common |
| 8 | Y/V COMMON | |
| 15 | Z/W COMMON | |
| 14 | Z/W COMMON | |
| 4 | X/U SHUT DOWN | |
| 10 | Y/V SHUT DOWN | Open Collector TTL |
| 16 | Z/W SHUT DOWN | Output Active High |
| 27 | RESERVED | |
| 33 | RESERVED | |
| 39 | RESERVED | |
| 26 | FAULT INPUT | Logic Input, 74LS27 With 1K Pull Up. Active High Must Be Pulled Low If Not Used |

**Mating Connector:**

| | **Aerotech Number** |
|---|---|
| 3M CONNECTOR 3564-1001 | (ECK 353) |

**or**

| | |
|---|---|
| AMP CONNECTOR 552032-1 | (ECK 320) |
| 90 BACKSHELL 552731-1 OR 180 BACKSHELL 552008-1 | (EIK 264) |

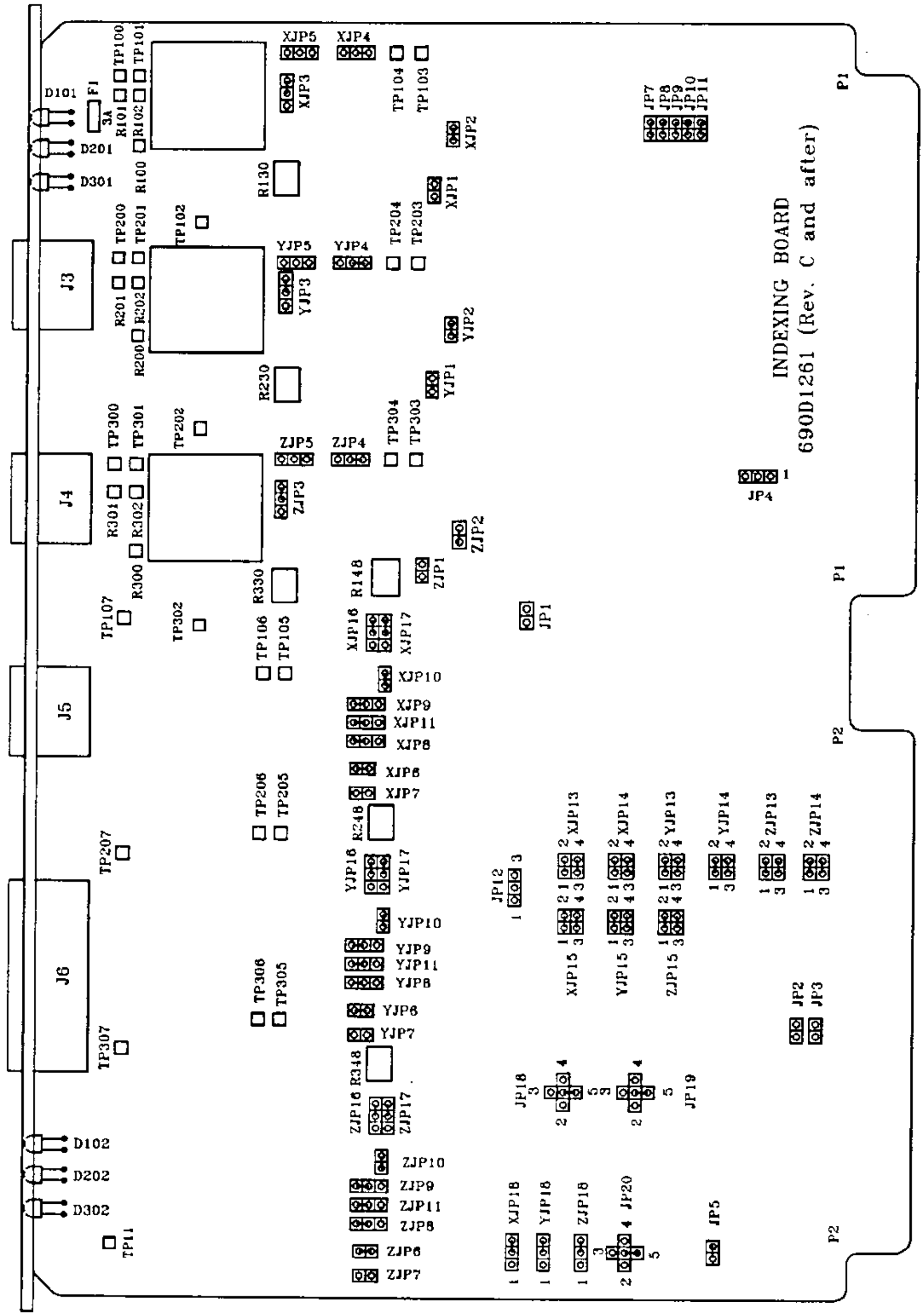



*Figure 7-4: Indexing Board*

Square Wave Encoder Board
690C1334 – Rev. A

Sine Wave Encoder Board
690C1333 – Rev. A

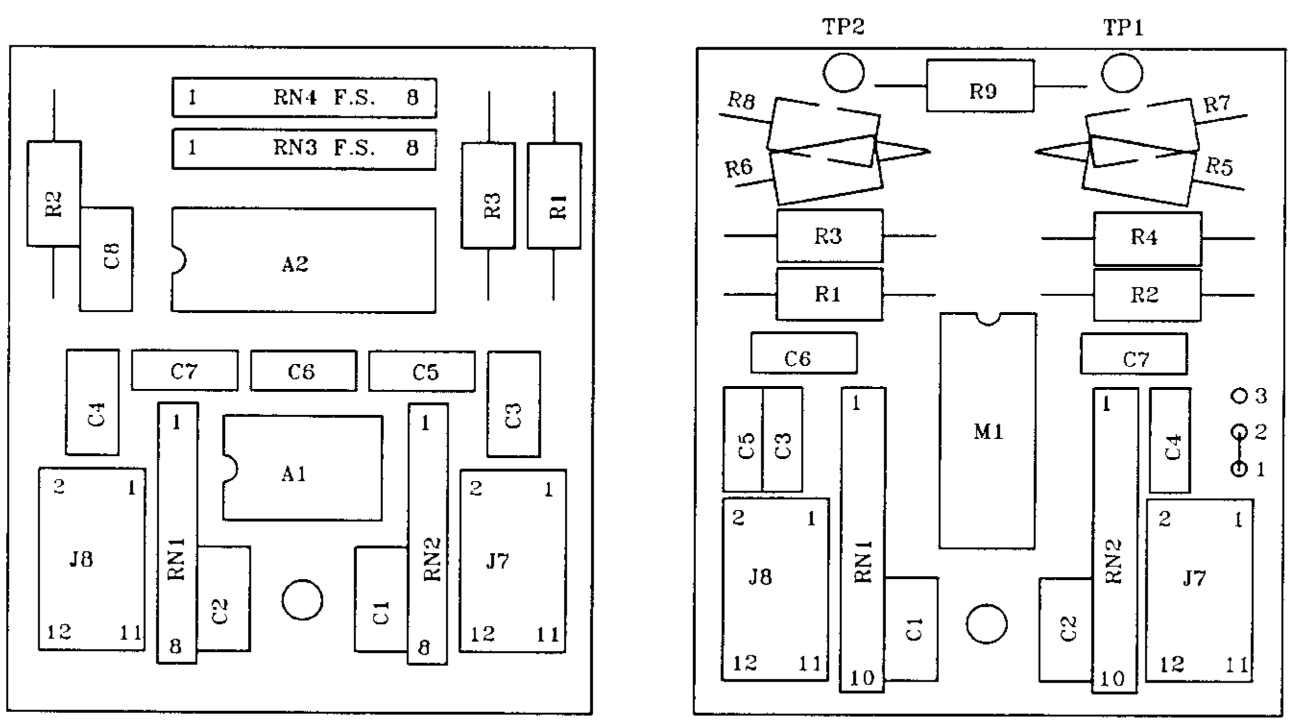



*Figure 7-5: Square Wave and Sine Wave Encoder Interface Boards*

## SECTION 7-5 FRONT PANEL BOARD

The Front Panel board is used to interface the front panel switches, keyboard, CRT monitor, and floppy disc drive to the Unidex 16 card cage. The board is mounted on the rear of the membrane front panel and is interconnected to the Unidex 16 card cage by means of two 50 line cables. For more detailed wiring information, please refer to system prints supplied with your system.

The Aerotech standard jumpers are indicated with an asterisk (*).

### A. MSO JUMPERS

| | |
|---|---|
| 1-2 | ASO (Analog Spindle Override) - Not Used |
| * 2-3 | MSO (Manual Spindle Override) |

### B. CRT VERTICAL SYNC JUMPERS

| | |
|---|---|
| * 4-5 | Ball BC190 Monitor |
| 5-6 | Not Used |

### C. HANDWHEEL JUMPERS

| | | |
|---|---|---|
| 7-8 | In | This option has never been |
| 9-10 | In | developed. However, this jumper |
| 11-12 | In | must be installed as shown for |
| 13-14 | In | proper operation. |

## D. KEYBOARD INTERFACE JUMPERS

| | RS-232 ASCII Keyboard | IBM PC Keyboard |
|---|---|---|
| 15-16 | Out | * In |
| 16-17 | In | * Out |
| 17-18 | Out | * In |

## E. ADJUSTMENTS

| | |
|---|---|
| R20 | CRT brightness control. |
| R27 | Factory selection. Not used. |
| R29 | Audio volume control for beeper. |

*See figure 7-6 for location of jumpers and adjustments.*

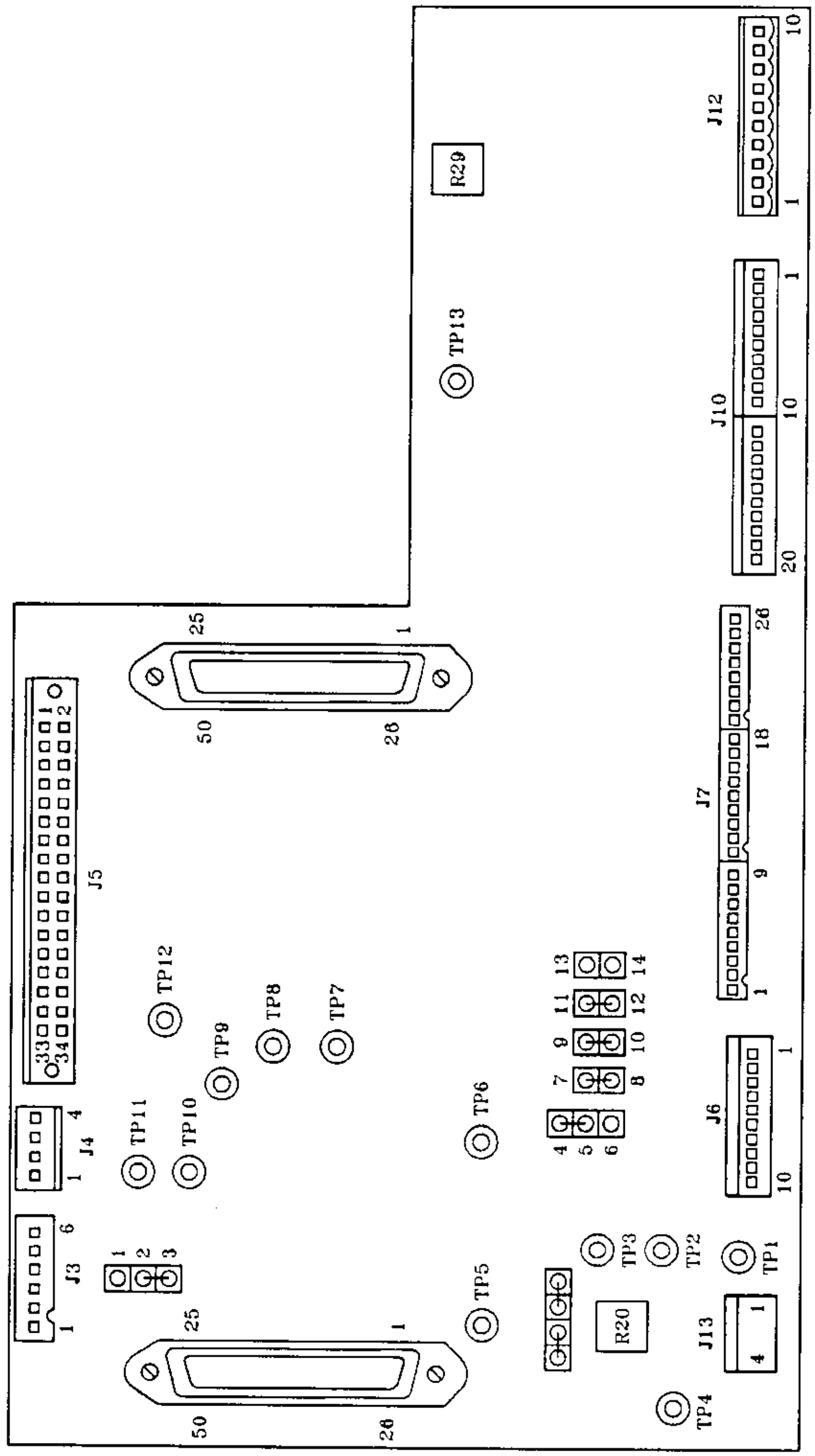



*Figure 7-6: Front Panel Board*

# CHAPTER 8: SERIAL COMMUNICATION

Unidex 16 provides you with two ports for serial communication. Each of them can be configured to accommodate RS-232 or RS-422 drivers.

**NOTE:** The conversion from one type of interface to the other type is accomplished by changing a jumper on the CPU board.

## SECTION 8-1 RS-232 PROTOCOL

### A. JUMPERS

To have Unidex 16 configured for an RS-232 driver, jumpers 33-34 (port-A) and 31-32 (port-B) on the CPU board are removed.

In order to communicate with different types of RS-232 devices, there are jumpers provided on the CPU board.

The following list (table 8-1) shows the possible selections:

| PORT-B | | PORT-A | |
|---|---|---|---|
| **Unidex 16 as Terminal** | **Unidex 16 as Modem** | **Unidex 16 as Terminal** | **Unidex 16 as Modem** |
| 35-36 | 36-37 | 7-8 | 8-9 |
| 38-39 | 39-40 | 10-11 | 11-12 |
| 41-42 | 42-43 | 13-14 | 14-15 |
| 44-45 | 45-46 | 16-17 | 17-18 |
| 47-48 | 48-49 | 19-20 | 20-21 |
| 50-51 | 51-52 | 22-23 | 23-24 |
| 53-54 | 54-55 | 25-26 | 26-27 |
| 56-57 | 57-58 | 28-29 | 29-30 |

**NOTE:** *All* jumpers of any of the above groups must be connected in order to achieve the correct results.

*Table 8-1: Jumper Selections for RS-232 Protocol*

## B. PIN-OUT FOR RS-232

The pin-out for the 25 pin connector, as well as the definitions of the RS-232 interface signals, are shown in table 8-2.

| PIN # | AS TERMINAL | AS MODEM |
|---|---|---|
| 1 | Shielding Gnd | Shielding Gnd |
| 2 | TXD | RXD |
| 3 | RXD | TXD |
| 4 | RTS | CTS |
| 5 | CTS | RTS |
| 6 | DSR | DTR |
| 7 | Signal Gnd | Signal Gnd |
| 8 | DCD | DCD |
| 20 | DTR | DSR |

**PIN-OUT FOR 25 PIN CONNECTOR**

**NOTE:** See figure 8-1 for RS-232 connections

| SIGNAL MNEMONICS | SIGNAL DESCRIPTION |
|---|---|
| Shielding Gnd | **Shielding Ground.** The common for the -12 VDC source. This line provides a safety ground connection directly to the power supply for RS-232C compatible devices. |
| TXD | **Transmit Data.** This line transfers data to an RS- 232 compatible device. |
| RXD | **Receive Data.** This line accepts input data from an RS-232 compatible device. |
| RTS | **Request To Send.** This output line is used to send a request signal to the RS-232 device so as to begin sending data. |
| CTS | **Clear To Send.** This line is a high level when the RS-232 device is ready to receive data. |
| DSR | **Data Set Ready.** This line is a high level when an RS-232 device is connected to the Basic Display Unit and and the device is operating. |
| Signal Gnd | **Signal Ground.** This line provides a common signal connection to the RS-232 device. |
| DCD | **Data Carrier Detect.** This line is a high level when the RS-232 device has detected the carrier signal. |
| DTR | **Data Terminal Ready.** This output line indicates to the RS-232 device that the Basic Display Unit is ready. |

**DEFINITIONS FOR RS-232 INTERFACE SIGNALS**

*Table 8-2: Pin-out for 25 Pin Connector/Definitions*

## SECTION 8-2 RS-422 PROTOCOL

**NOTE:** When using RS-422, Unidex 16 is always configured as a terminal.

### A. JUMPERS

For RS-422 protocol, jumpers 33-34 (port-A) and 31-32 (port-B) on the CPU board must be connected. Remove jumpers 7 - 30 for port-A. Remove jumpers 35 - 58 for port-B.

### B. PIN-OUT FOR RS-422

The pin-out for the 37 pin connector is shown in table 8-3a. Definitions of the RS-422 interface signals are shown in table 8-3b.

| PIN # | SIGNAL |
|---|---|
| 1 | SHIELDING GND |
| 4 | SD |
| 22 | SD REF |
| 7 | RS |
| 25 | RS REF |
| 12 | TR |
| 30 | TR REF |
| 24 | RD |
| 6 | RD REF |
| 29 | DM |
| 11 | DM REF |
| 27 | CS |
| 9 | CS REF |
| 31 | RR |
| 13 | RR REF |

*Table 8-3 A: Pin-out for 37 Pin Connector*

| Signal Mnemonics | Circuit Name | Direction |
|---|---|---|
| TR | Terminal Ready | To DCE |
| DM | Data Mode | From DCE |
| SD | Send Data | To DCE |
| RD | Receive Data | From DCE |
| RS | Request to Send | To DCE |
| CS | Clear to Send | From DCE |
| RR | Receiver Ready | From DCE |

**DEFINITIONS OF RS-422 INTERFACE SIGNALS**

*Table 8-3 B: Pin-out for 37 Pin Connector/Definitions*

## SECTION 8-3 REMOTE CONTROL

Remote control allows you to operate Unidex 16 via a host controller. Only the host system can enable remote operation by sending ASCII Code (OBH) - Remote ON.

In order to operate Unidex 16 through a remote controller, the following hardware instructions are necessary.

- Remote control can be interfaced only through port-A (RS-232 or RS-422).
- Both host system and Unidex 16 should be set at the same baud rate, parity, stop bit, and bit/character. (Remember, any time a Unidex 16 parameter changes, the system must be < RESET > in order to enable it.)
- Set Unidex 16's CPU board jumpers according to the host system's RS-232 configuration, (DCE or DTE).

Consult *Unidex 16 Motion Controller Programming Manual*, chapter 13, for operation.

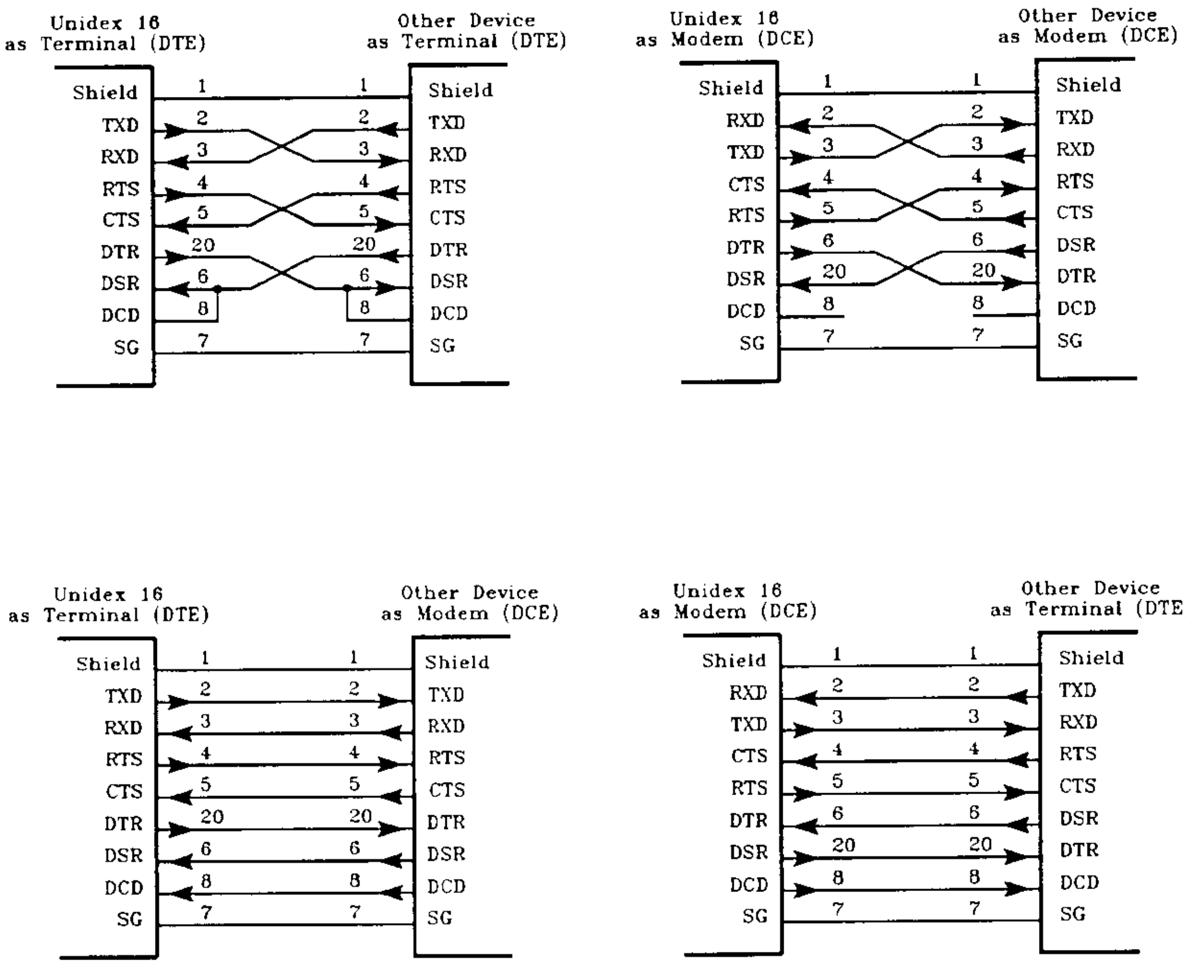



*Figure 8-1: RS-232 Configurations*

# CHAPTER 9: UNIDEX 16 MST BUS AND I/O BUS

The Unidex 16 I/O bus and MST bus originates from the Unidex 16 CRT board (A3) J5 and J4 connectors respectively.

The Unidex 16 I/O Bus conforms to the Motorola I/O Channel specification M68RIOCS. The following information is intended to clarify the use of I/O Modules in the Unidex 16 I/O bus.

The MST Bus and I/O Bus configuration is shown in the figure 9-1. The VME Card Cage configuration is shown in figure 9-2.

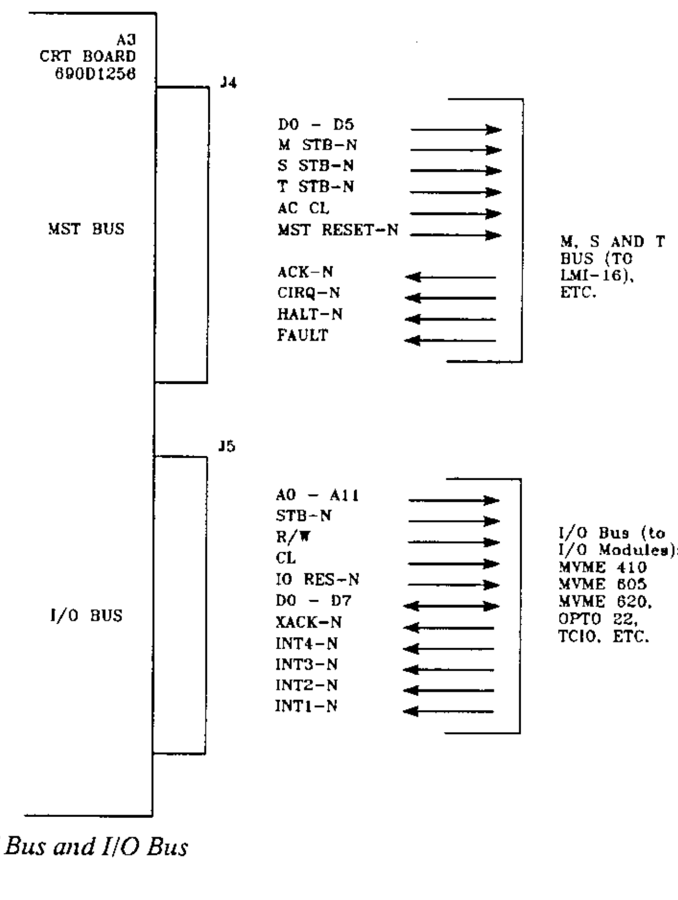



*Figure 9-1: MST Bus and I/O Bus*

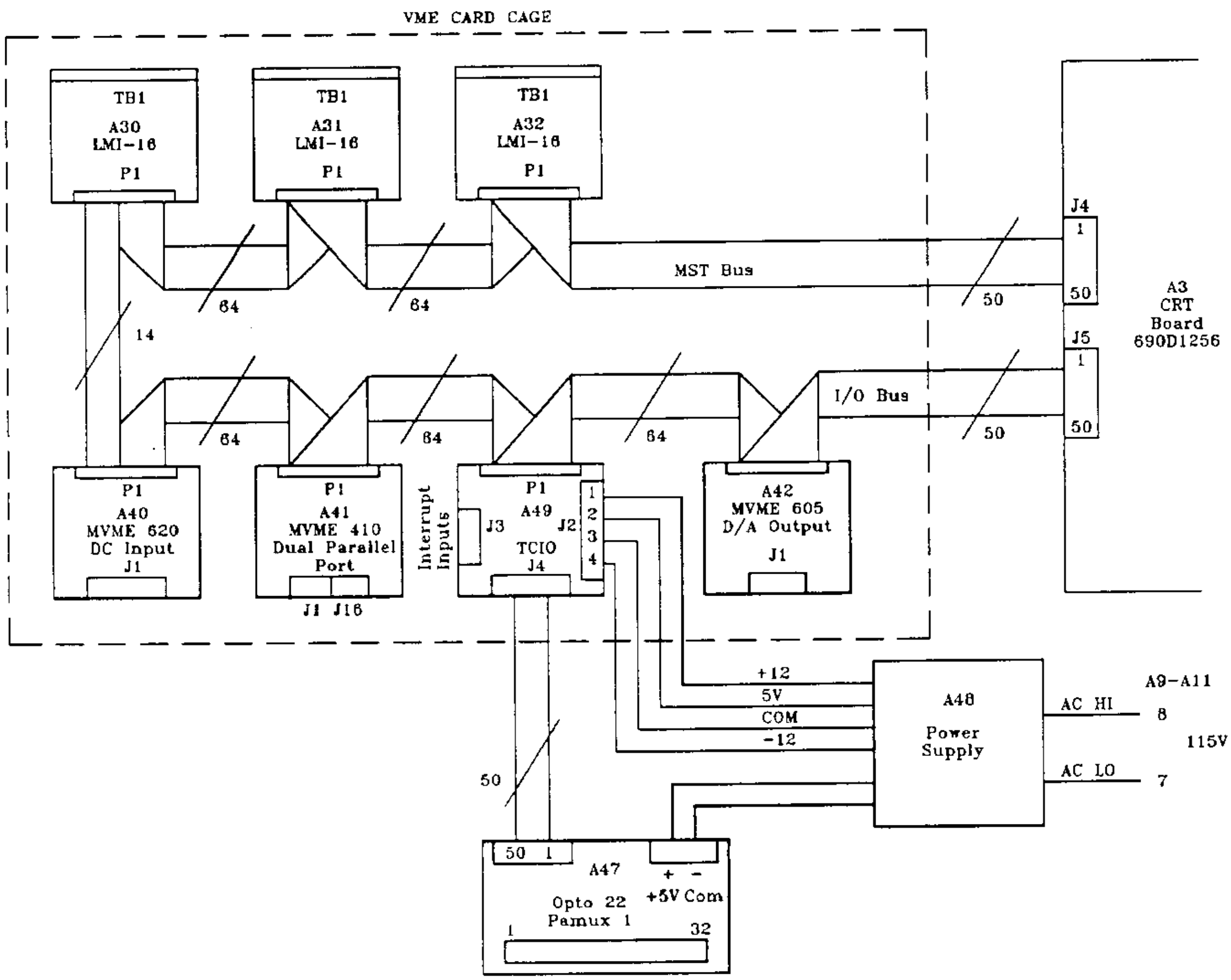



*Figure 9-2: VME Card Cage*

## SECTION 9-1 I/O CHANNEL

The I/O channel is one of the features that distinguishes Unidex 16 from other traditional numerical controllers. This is a high speed TTL data path that can be accessed directly by the parts program, in real time, to perform input or output operations.

The I/O channel, originally developed and supported by Motorola, allows Unidex 16 to be tailored to fit different control requirements by adding specialized hardware to the basic system through a standard bus. This greatly simplifies programming, interfacing and packaging of the overall system.

From Motorola, there are boards, mostly standard single Eurocard size, that can perform a whole range of functions from input, output to A/D, D/A conversion. Only a flat ribbon cable is needed to daisy chain these boards to the Unidex 16 card cage. Since the bus protocol is relatively simple, you can easily develop your own hardware for your special needs as well.

The bus is 8 bits wide (one byte), however 4096 bytes of data can be addressed through 12 address lines. Among these addresses, the first 2048 locations are accessible from the user's parts program. The rest of them are reserved for system use.

I/O statements are simplified to perform 8, 16, 24 or 32 bits of data transfer with one code word. Both BCD and Binary data types are supported.

### A. I/O PROGRAMMING AND FORMAT

Inputs or outputs are done using assignment or parametric code words. (Refer to section 12-1 of the *Unidex 16 Motion Controller Programming Manual.*)

The Unidex 16 I/O Format for most I/O modules will be one byte binary, using the programming command:

**(IOFT,BIN,1)**

## B. BUS DEFINITION

Detailed specifications on the standard Motorola I/O channel can be found in appendix 1. The I/O channel on Unidex 16 conforms to all timing and drive specifications for a bus master. Table (table 9-1) highlights all bus signals. Figure 9- 4 shows the timing diagram.

## C. SYSTEM AND PACKAGING

The I/O channel contains two groups of lines: signal and power. These lines can be connected with ribbon cable. All signal lines are grouped together to form a 50 line ribbon cable. All power lines are grouped together to form a 14 line ribbon cable.

At each I/Omodule, a "drop" is made by terminating both cables to a 64 pin female DIN connector.

The DIN connector plugs directly into a standard Eurocard-size I/O card. Since many DIN connectors can be terminated on one ribbon cable, busing is done easily in a daisy chain fashion. Up to 16 I/O cards can be used over a distance of 12 feet.

The basic Unidex 16 has a power supply that can support two I/Omodules. Signal lines are brought out from the J5 connector of the CRT board. Power lines are accessible from J4 of the power supply. An optional split 64 conductor ribbon cable is available to accommodate both connections and provides two "drops" to the system. Additional I/Omodules would require additional power supplies.

## D. ADDRESSING

The I/O bus address is offset one bit to the left of the Versabus address. Only odd Versabus addresses are used for the I/O channel. Therefore, twice the I/O bus address plus one (2N + 1) equals the Versabus address.

In some of the Motorola I/O Module manuals, the address jumper instructions refer to the Versabus address while in other Motorola I/O Module manuals, the address jumper instructions refer to the I/O bus address. The hexadecimal I/O bus address will always be used when programming Unidex 16. For example:

**$100=H,FF outputs binary 11111111 to the 8 LSB register of DAC #1**

The I/O bus addressing memory map is shown in figure 9-3.

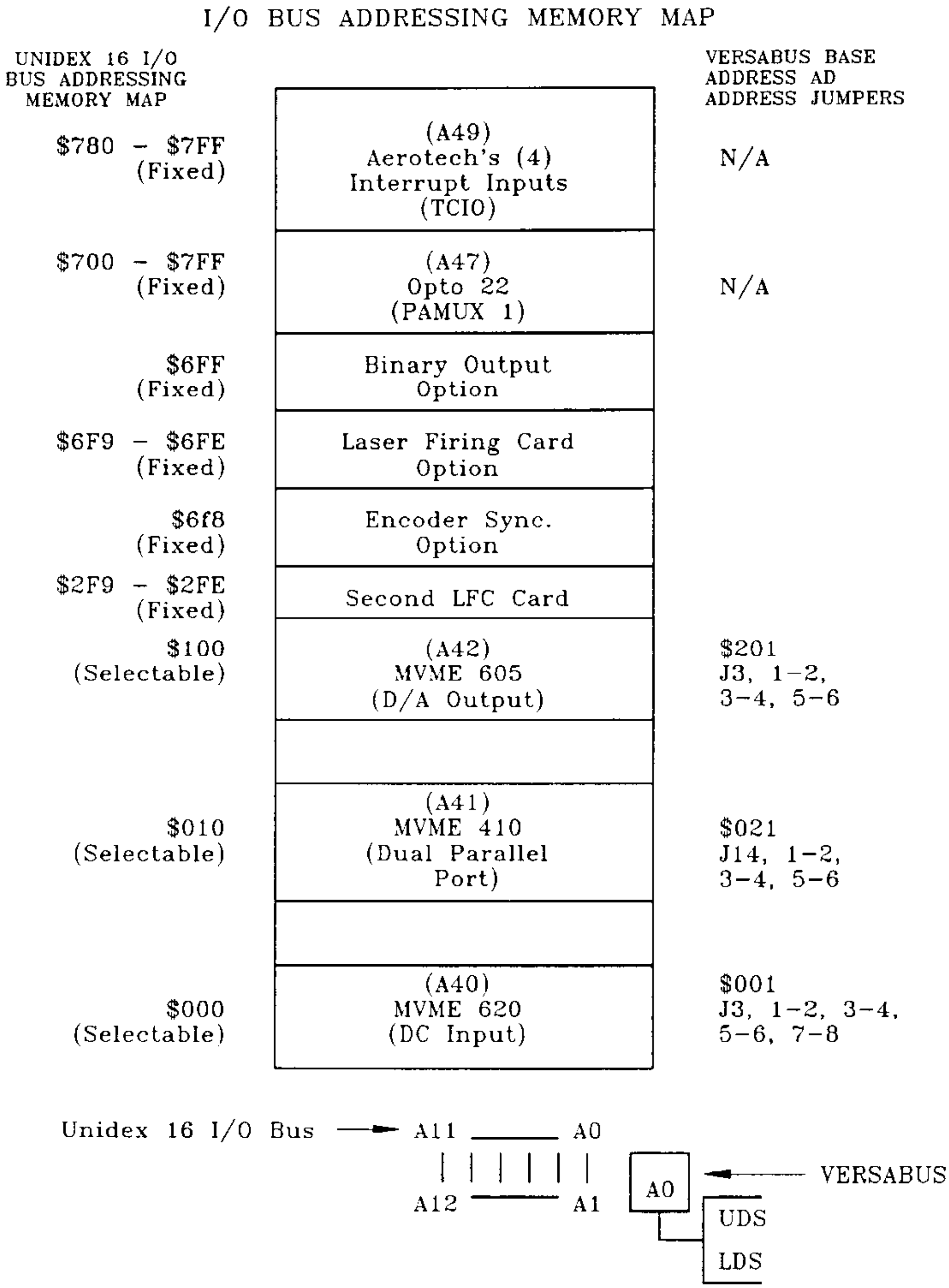
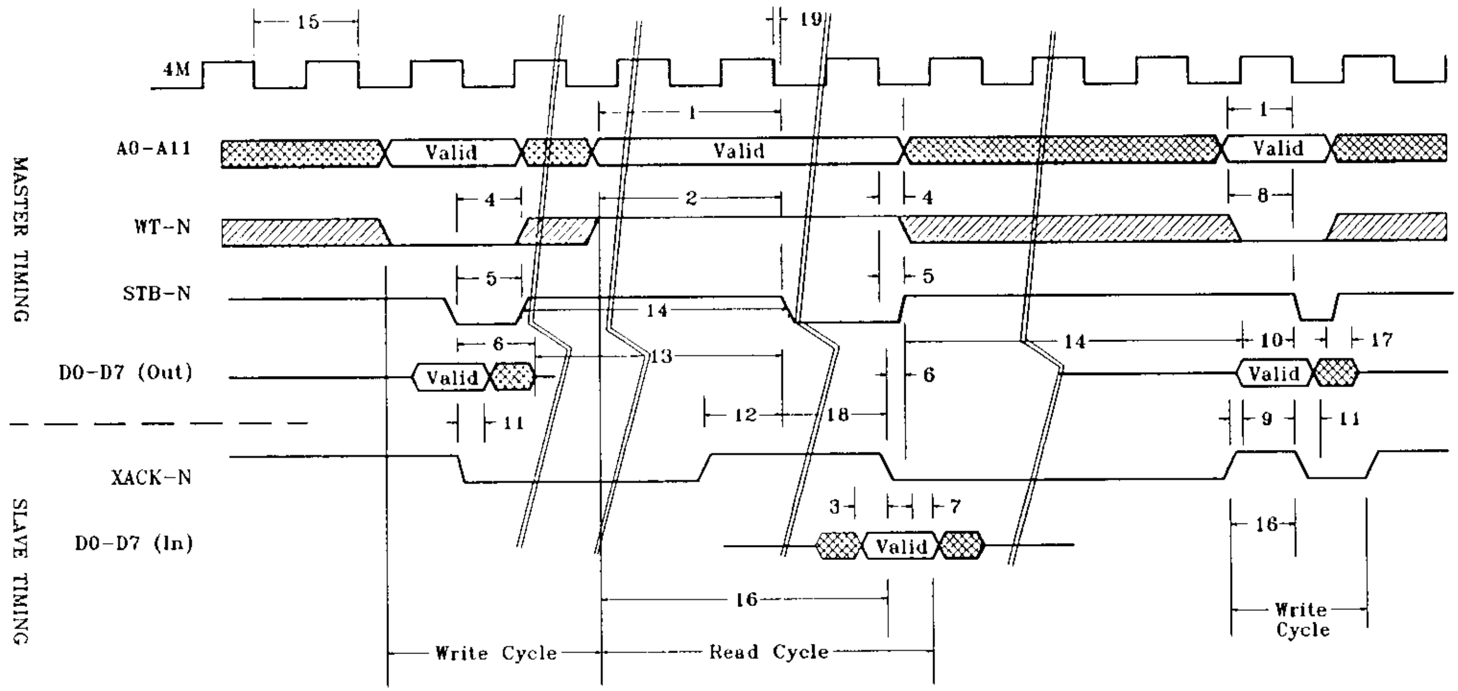



*Figure 9-3: I/O Bus Addressing Memory Map*

| | 64 PIN DIN CONNECTOR | CRT J5 (26-50) OR PS J4 (8-14) | 64 CONDUCTOR RIBBON CABLE | 50 CONDUCTOR RIBBON CABLE | SIGNAL MNEMONIC | 64 PIN DIN CONNECTOR | CRT J5 (1-25) OR PS J4 (1-7) | 64 CONDUCTOR RIBBON CABLE | 50 CONDUCTOR RIBBON CABLE | SIGNAL MNEMONIC |
|---|---|---|---|---|---|---|---|---|---|---|
| I/O Channel Signal Lines, CRT, J5 | C1 | 50 | 64 | 50 | INT4-N | A1 | 25 | 63 | 49 | Ground |
| | C2 | 49 | 62 | 48 | INT3-N | A2 | 24 | 61 | 47 | Ground |
| | C3 | 48 | 60 | 46 | INT2-N | A3 | 23 | 59 | 45 | Ground |
| | C4 | 47 | 58 | 44 | INT1-N | A4 | 22 | 57 | 43 | Ground |
| | C5 | 46 | 56 | 42 | IORES-N | A5 | 21 | 55 | 41 | Ground |
| | C6 | 45 | 54 | 40 | XACK-N | A6 | 20 | 53 | 39 | Ground |
| | C7 | 44 | 52 | 38 | CLK | A7 | 19 | 51 | 37 | Ground |
| | C8 | 43 | 50 | 36 | Reserved | A8 | 18 | 49 | 35 | Ground |
| | C9 | 42 | 48 | 34 | Reserved | A9 | 17 | 47 | 33 | Ground |
| | C10 | 41 | 46 | 32 | Reserved | A10 | 16 | 45 | 31 | Ground |
| | C11 | 40 | 44 | 30 | Ground | A11 | 15 | 43 | 29 | A11 |
| | C12 | 39 | 42 | 28 | A9 | A12 | 14 | 41 | 27 | A10 |
| | C13 | 38 | 40 | 26 | A7 | A13 | 13 | 39 | 25 | A8 |
| | C14 | 37 | 38 | 24 | A5 | A14 | 12 | 37 | 23 | A6 |
| | C15 | 36 | 36 | 22 | A3 | A15 | 11 | 35 | 21 | A4 |
| | C16 | 35 | 34 | 20 | A1 | A16 | 10 | 33 | 19 | A2 |
| | C17 | 34 | 32 | 18 | A0 | A17 | 9 | 31 | 17 | Ground |
| | C18 | 33 | 30 | 16 | STB-N | A18 | 8 | 29 | 15 | Ground |
| | C19 | 32 | 28 | 14 | WT-N | A19 | 7 | 27 | 13 | Ground |
| | C20 | 31 | 26 | 12 | Ground | A20 | 6 | 25 | 11 | D7 |
| | C21 | 30 | 24 | 10 | D5 | A21 | 5 | 23 | 9 | D6 |
| | C22 | 29 | 22 | 8 | D3 | A22 | 4 | 21 | 7 | D4 |
| | C23 | 28 | 20 | 6 | D1 | A23 | 3 | 19 | 5 | D2 |
| | C24 | 27 | 18 | 4 | D0 | A24 | 2 | 17 | 3 | Ground |
| | C25 | 26 | 16 | 2 | Ground | A25 | 1 | 15 | 1 | Ground |
| I/O Channel Power Lines, PS, J4 | C26 | 14 | 14 | | -12 V | A26 | 7 | 13 | | -12 V |
| | C27 | 13 | 12 | | Reserved | A27 | 6 | 11 | | Reserved |
| | C28 | 12 | 10 | | +12 V | A28 | 5 | 9 | | +12 V |
| | C29 | 11 | 8 | | +5 V | A29 | 4 | 7 | | +5 V |
| | C30 | 10 | 6 | | +5 V | A30 | 3 | 5 | | +5 V |
| | C31 | 9 | 4 | | Ground | A31 | 2 | 3 | | Ground |
| | C32 | 8 | 2 | | Ground | A32 | 1 | 1 | | Ground |

*Table 9-1: Pin Assignments for I/O Channel*




| NUMBER | DESCRIPTION | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| 1 | Address valid to STB low | 125 | -- | NS | 1.2 |
| 2 | WT High to STB low | 125 | -- | NS | 2 |
| 3 | Data-in valid to XACK low | 50 | -- | NS | 2 |
| 4 | XACK low to address invalid | 0 | -- | -- | 1.2 |
| 5 | XACK low to WT invalid | 0 | -- | -- | 1.2 |
| 6 | XACK low to STB high | 0 | 2.0 | US | 1.2 |
| 7 | STB high to data-in invalid | 0 | -- | 00 | 2 |
| 8 | WT low to STB low | 125 | -- | NS | 1 |
| 9 | XACK high to data-out driven | 0 | -- | 00 | 1 |
| 10 | Data-out valid to STB low | 125 | -- | NS | 1 |
| 11 | XACK low to data-out invalid | 0 | -- | -- | 1 |
| 12 | XACK high to STB low | 125 | -- | -- | 2 |
| 13 | Data-out hi-Z to STB low | 0 | -- | -- | 2 |
| 14 | STB high time | 125 | -- | NS | 1.2 |
| 15 | 4M Hz clock period | 245 | 255 | NS | 1.2 |
| 16 | Address valid to XACK-N low | -- | 60 | US | 1.2 |
| 17 | STB-N high to data-out hi-Z | 0 | 25 | NS | 1 |
| 18 | STB-N low to ACK-N low | 0 | -- | NS | 1.2 |
| 19 | 4M low to STB-N low | 0 | 40 | NS | 1.2 |

NOTES: 1. Write Cycle
2. Read Cycle

*Figure 9-4: I/O Channel Signal Timing*

A remote I/O card cage can be added to the system if extensive I/O capability is needed. Optional hardware can be ordered directly from Motorola or other vendors. A partial list of components is:

## I/O modules *

| PART NO. | DESCRIPTION | VENDOR |
|---|---|---|
| MVME410 | Dual 16-Bit Parallel I/O Module, 4 independent 8-bit TTL parallel input/output with handshake lines. | Motorala |
| MVME600 | 12-Bit A/D, I/O Channel Module, 16 single ended or 8 differential 12 bit A/D channels with selectable input range. | Motorola |
| MVME601 | Expander Module for MVME600 | Motorola |
| MVME 605 | 12-Bit D/A I/O Channel Module, 4 independent 12 bit channels, selectable output range. | Motorola |
| MVME610 | A/C Input I/O Channel Module, 8 independent optically isolated AC inputs. | Motorola |
| MVME615 | A/C Output I/O Channel Module (zero x-over), 8 independent optically isolated 2A zero crossing solid state relays. | Motorola |
| MVME616 | A/C Output I/O Channel Module (Phase Angle), 8 independent optically isolated 2A non-zero corssing solid state relays. | Motorola |
| MVME620 | D/C Input I/O Channel Module, 8 independent optically isolated differential inputs. | Motorola |

| | | |
|---|---|---|
| MVME625 | D/C Output I/O Channel Module, 8 independent optically isolated 2A outputs. | Motorola |

* Refer to Motorola's *16/32 Bit MCU System Components* (1984) data book for details.

## SECTION 9-2 M.S.T. FUNCTION OUTPUT

A comprehensive output bus is provided for M, S or T functions. When these codewords are executed in the parts program, data is sent out in TTL levels together with a "strobe". If an "acknowledge" signal is asserted, the output cycle will complete and Unidex 16 will proceed to execute the next codeword. One strobe line is provided for each function. All M, S, and T functions share the same acknowledge line. Since timing is very relaxed and many variations can be programmed by the parameter setting, the output bus is well suited for driving machine control relays or a programmable controller.

### A. BUS DEFINITION

Similar to the I/O channel, the M.S.T. bus contains signal and power lines. Among signal lines, there are data, strobe and acknowledge. All signal lines are accessible on J4 of the CRT board. See table 9-2 for pin assignments.

Throughout the following paragraph, the term "asserted" is used to describe a signal being driven to its active state. If the signal is active high, the voltage will be TTL high level ( 2.0V ). If the signal is active low, the voltage will be TTL low level ( .8V ). The term "negated" is used for a signal in an inactive state. This is the opposite of the "asserted" state.

## 1. BUS PROTOCOL

The sequence of events for a typical bus cycle is:

- Data appears on bus.
- System waits (parameter MTMF, STMF or TTMF) and then asserts "stobe".
- System waits for acknowledge to come.
- Acknowledge is debounced for certain amount of time (parameter MTFN, STFN or TTFN).
- "Strobe" is negated.
- System waits for the "acknowlege" to disappear (negated).

Three different types of handshake are provided. Every one is available to the M, S or T function output by parameter setting. The only difference between these functions is the strobe line. Each function has its own strobe. Figure 9-5 shows all three types of timing for the M function output. S and T function outputs are similar.

*TYPE A:* This can be used to interface to a slow, unlatched relay sequencer where an output on Unidex 16 is used to start a sequence of action (for example, punch sequence or tool change) and Unidex 16 has to wait for the completion of the cycle before it executes the next codeword. In this case, data and strobe lines can be used to actuate the sequence and the acknowledge line can be held inactive to stop Unidex 16 during the sequence. Upon completion, the acknowledge line can be asserted and Unidex 16 can complete the output cycle.

*TYPE B:* This type of output is useful where hardware action is needed to signal the execution of a codeword, but no handshake is required. An outside device can decode data and strobe, and use them to trigger an event. Since no handshake is performed, there is minimum delay in program execution. Also hardware is simplified.

*TYPE C:* This type is useful where acknowledge is not critical during output operation. Unidex 16 will perform the entire bus sequence, except the total bus cycle time is limited. Once the total time is exceeded, Unidex 16 will go on to the next codeword. This can be used to run a parts program without actual I/O connections. Therefore, Type C is good for program testing.

## 2. MISCELLANEOUS SIGNALS

### *a. FAULT*

This is an open collector driven safety input for the system. It has to be pulled to logic low for normal operation. If the line is driven high or left unconnected, the system is considered to be in a faulty condition. The CRT will show "Warning, drive fault" and react to the condition depending on the parameter setting. Normally, this signal is internally converted to the "shut down" line of servo amplifiers. If "Fault" goes high, "Shut down" will follow and thus all driver motors will be disabled.

Note that only one module should drive this line low. If more than one module drives the line low, the system will not register a fault. This is because when one module releases the fault, other modules still hold the line low. Therefore, no fault is detected.

### *b. HALT-N*

This input line can be used as "feed hold" in the system to stop all positioning clocks. When the line is driven low (HALT-N), Unidex 16 will stop the indexing clock and act according to

| Group | 64 PIN DIN CONNECTOR | CRT J4 (26-50) OR PS J4 (8-14) | 64 CONDUCTOR RIBBON CABLE | 50 CONDUCTOR RIBBON CABLE | SIGNAL MNEMONIC | INPUT OR OUTPUT | 64 PIN DIN CONNECTOR | CRT J4 (1-25) OR PS J4 (1-7) | 64 CONDUCTOR RIBBON CABLE | 50 CONDUCTOR RIBBON CABLE | SIGNAL MNEMONIC | INPUT OR OUTPUT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M.S.T Bus Signal Lines, CRT, J4 | C1 | 50 | 64 | 50 | CIRQ4-N | I | A1 | 25 | 63 | 49 | Ground | O |
| | C2 | 49 | 62 | 48 | FAULT | I | A2 | 24 | 61 | 47 | Ground | O |
| | C3 | 48 | 60 | 46 | HALT-N | I | A3 | 23 | 59 | 45 | Ground | O |
| | C4 | 47 | 58 | 44 | Spare | – | A4 | 22 | 57 | 43 | Ground | O |
| | C5 | 46 | 56 | 42 | MSTRST-N | O | A5 | 21 | 55 | 41 | Ground | O |
| | C6 | 45 | 54 | 40 | ACK-N | I | A6 | 20 | 53 | 39 | Ground | O |
| | C7 | 44 | 52 | 38 | ACCLK | O | A7 | 19 | 51 | 37 | Ground | O |
| | C8 | 43 | 50 | 36 | Spare | – | A8 | 18 | 49 | 35 | Ground | O |
| | C9 | 42 | 48 | 34 | SSTB-N | O | A9 | 17 | 47 | 33 | Ground | O |
| | C10 | 41 | 46 | 32 | TSTB-N | O | A10 | 16 | 45 | 31 | Ground | O |
| | C11 | 40 | 44 | 30 | Ground | O | A11 | 15 | 43 | 29 | Spare | – |
| | C12 | 39 | 42 | 28 | Spare | – | A12 | 14 | 41 | 27 | Reserved | – |
| | C13 | 38 | 40 | 26 | Spare | – | A13 | 13 | 39 | 25 | D15 | O |
| | C14 | 37 | 38 | 24 | D13 | O | A14 | 12 | 37 | 23 | D14 | O |
| | C15 | 36 | 36 | 22 | D11 | O | A15 | 11 | 35 | 21 | D12 | O |
| | C16 | 35 | 34 | 20 | D9 | O | A16 | 10 | 33 | 19 | D10 | O |
| | C17 | 34 | 32 | 18 | D8 | O | A17 | 9 | 31 | 17 | Ground | O |
| | C18 | 33 | 30 | 16 | MSTB-N | O | A18 | 8 | 29 | 15 | Ground | O |
| | C19 | 32 | 28 | 14 | Reserved | O | A19 | 7 | 27 | 13 | Ground | O |
| | C20 | 31 | 26 | 12 | Ground | O | A20 | 6 | 25 | 11 | D7 | O |
| | C21 | 30 | 24 | 10 | D5 | O | A21 | 5 | 23 | 9 | D6 | O |
| | C22 | 29 | 22 | 8 | D3 | O | A22 | 4 | 21 | 7 | D4 | O |
| | C23 | 28 | 20 | 6 | D1 | O | A23 | 3 | 19 | 5 | D2 | O |
| | C24 | 27 | 18 | 4 | D0 | O | A24 | 2 | 17 | 3 | Ground | O |
| | C25 | 26 | 16 | 2 | Ground | O | A25 | 1 | 15 | 1 | Ground | O |
| M.S.T. Bus Power Lines, PS, J4 | C26 | 14 | 14 | | -12 V | O | A26 | 7 | 13 | | -12 V | O |
| | C27 | 13 | 12 | | Reserved | – | A27 | 6 | 11 | | Reserved | – |
| | C28 | 12 | 10 | | +12 V | O | A28 | 5 | 9 | | +12 V | O |
| | C29 | 11 | 8 | | +5 V | O | A29 | 4 | 7 | | +5 V | O |
| | C30 | 10 | 6 | | +5 V | O | A30 | 3 | 5 | | +5 V | O |
| | C31 | 9 | 4 | | Ground | O | A31 | 2 | 3 | | Ground | O |
| | C32 | 8 | 2 | | Ground | O | A32 | 1 | 1 | | Ground | O |

*Table 9-2: Pin Assignments for M.S.T. Bus*

the parameter setting. Since the servo loop has a deceleration feature, motors will not stop immediately. They will slow down to a gradual stop. This is similar to pushing the front panel FEEDHOLD key. All motion and program execution will be held indefinitely if the line is kept low. Parameters can be set to display "Warning, D/A overrun or HALT" or not. Also, the machine can be set to the "single" mode, if desired, after the line is released. The last case allows Unidex 16 to finish the current block of program and stop.

Unidex 16 internally can also activate this line when the D/A converter saturates due to overspeed or amplifier shutdown.

c. *MSTRST-N*

This is an active low output that is derived from the system reset. It is driven active upon power up so peripheral devices can be cleared to a predetermined state. It is also driven active when the front panel reset button is depressed.

d. *ACCLK*

This is the AC clock output derived from the power supply AC input. It is closely in phase with the AC line (within 2% of the total AC period). Therefore, it can be used to synchronize the relay switching to the AC zero crossing.

e. *CIRQ-N*

This is an active low interrupt input reserved for future expansion.

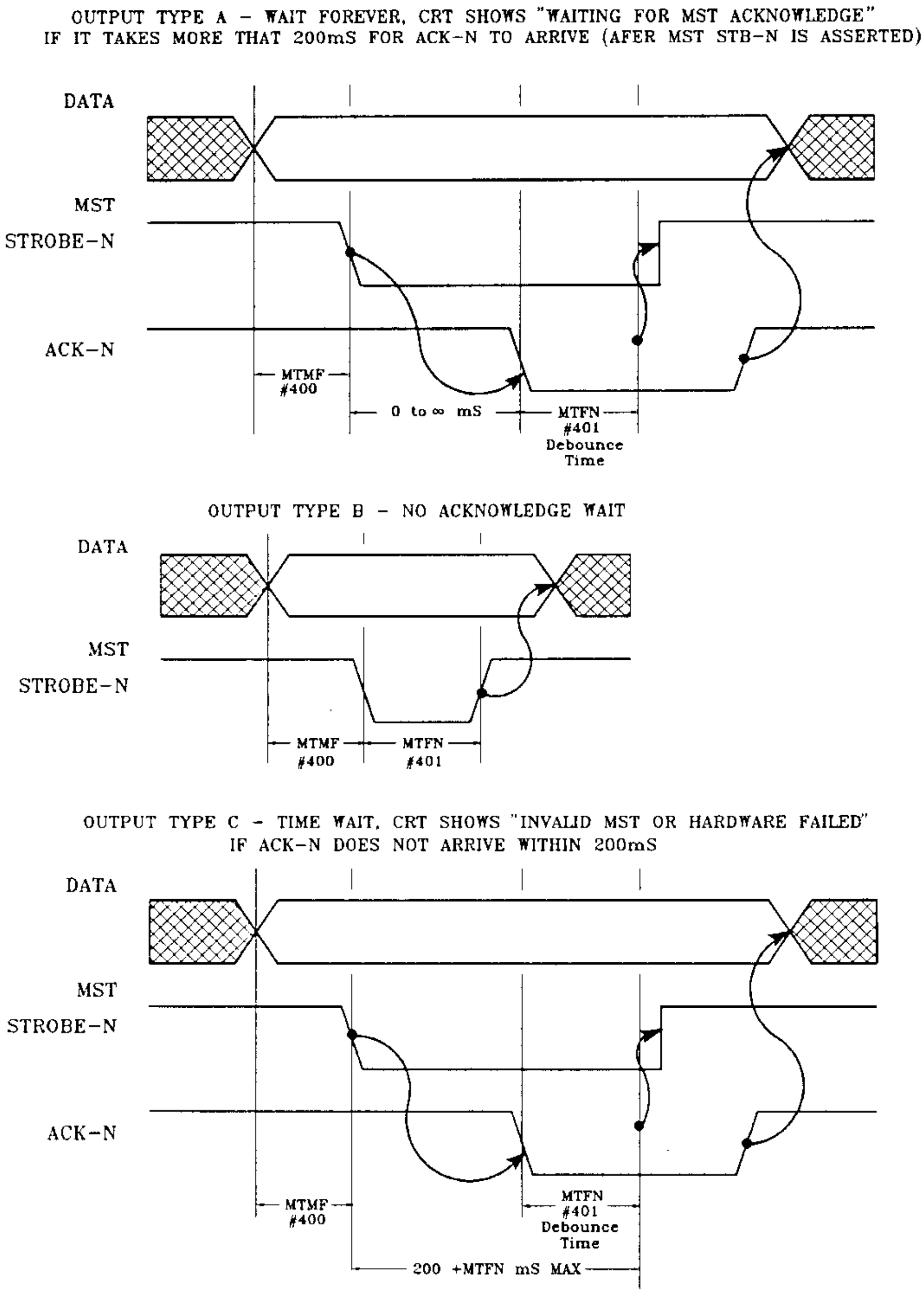



*Figure 9-5: M.S.T. Signal Timing*

## B. INTERFACING

Interfacing to the M.S.T. bus is very easy and straightforward. Figure 9-6 illustrates a decoding scheme that will respond to an M0 code. Two 4028 CMOS IC monitors lower data lines (D0 - D7) and decode two digits of BCD data. The following 4023 gate will have its output go low when M0 is output. This can be used to activate peripheral devices. If a jumper is set between 1 and 2, the acknowledge is provided automatically. If a jumper is set between 2 and 3, an external acknowledge is needed to complete the cycle. Other M codes can easily be decoded by adding more NAND gates.

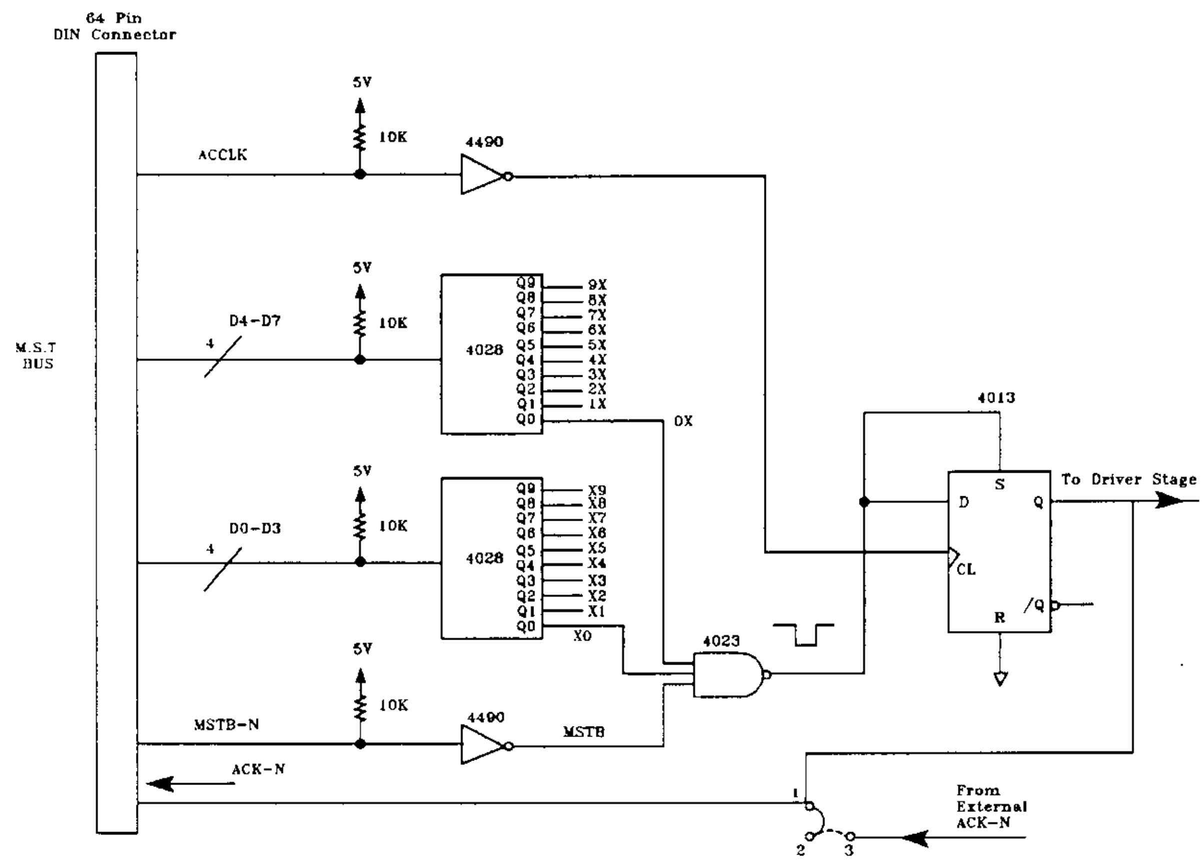



*Figure 9-6: Decoding Scheme for M0*

## C. SYSTEM AND PACKAGING

Like the I/O channel, the M.S.T. bus can be brought out from the CRT board using a flat ribbon cable. Many mass terminated connectors can be crimped onto one cable and can become many "drops". At each "drop" a module can be attached to the bus and perform a different function. Typically, DIN connectors can be used together with a Eurocard for ease of packaging. However, other connectors or even round cable can be used.

The cable length and drive capability is the same as that of the I/O channel, 12 feet and 16 drops.

The basic Unidex 16 has a power supply capable of supporting two Aerotech developed M.S.T. function boards if no I/Omodule is used. More M.S.T. function boards would need additional power supplies for support.

# CHAPTER 10: UNIDEX 16 OPTIONS

The Unidex 16 Options that have no hardware considerations are excluded from this chapter. Details on the operation of all Unidex 16 options can be found in chapter 13 of the *Unidex 16 Motion Controller Programming Manual.*

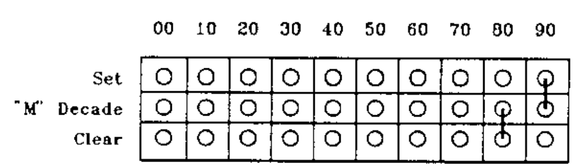
## SECTION 10-1 LMI CARD

Each LMI-16 (Latched M-function Interface) card assembly provides ten form-C latched relay circuits rated 115VAC, 28DC, 5A resistive.

**NOTE:** Aerotech standards will be indicated by an asterisk (*).

### A. ADDRESS JUMPERS

Although no address lines exist on the MST bus, each LMI-16 card can be jumpered to respond to two decades of M-function data (M00 - M99). As an example, the first LMI-16 card (A30) will set one of 10 latched relay outputs with M-function commands M90 through M99 and reset (clear) one of 10 latched relay outputs with M- function commands M80 through M89, as shown in the following illustration.




00 to 90 Jumpers on LMI Board

| LMI CARD | SET JUMPER | CLEAR JUMPER |
|---|---|---|
| A30 (1ST LMI) | M90* | M80* |
| A31 (2ND LMI) | M70* | M60* |
| A32 (3RD LMI) | M50* | M20* |

Notice the LMI card at A32 has its clear jumpers configured as M20-M29. The reason the M40 decade is not used is because M47 is usually a software command ("repeat program"). As mentioned previously, the MST bus can accommodate up to 3 LMI-16 cards.

## B. RESET-N JUMPER

| JP 3-4 | |
|---|---|
| IN | * MST RESET-N will clear latched outputs |
| OUT | MST RESET-N disabled |

When foil jumper 3-4 is IN, MST reset (front panel reset) will clear all M-functions.

## C. M STROBE-N

| JP 13-14 | |
|---|---|
| IN | * M STROBE-N active |
| OUT | M STROBE-N not required |

Jumper 13-14 must be in when used with Unidex 16. Jumper 13-14 is provided for other applications.

**NOTE:** A logic signal followed by "-N" indicates active low.

## D. LMI INPUTS AND ASSOCIATED JUMPERS

### *1. ACKNOWLEDGE INPUT (INPUT #1)*

**TB1-34 is ACK-HI**
**TB1-35 is ACK-LO**

Each device on the MST bus normally generates an acknowledge signal when communicating with Unidex 16. The acknowledge input is used by Unidex 16 for handshaking with external devices. An acknowledge can originate from the LMI card itself or from an external device via the LMI-16 acknowledge inputs.

The acknowledge may be one of three types, explained fully in chapter 9 of this manual. They are:

**TYPE A:** Output code to bus, wait forever for acknowledge.

**TYPE B:** Output code to bus, no acknowledge.

**TYPE C:** Output code to bus, wait for timed acknowledge.

The "S" and "C" jumpers will determine if the acknowledge signal will be generated locally (on the LMI board) or externally through the LMI board acknowledge input. The "S" jumper corresponds to the ACK signal generated when setting the output relays MX0 - MX9. The "C" jumper corresponds to the ACK signal generated when clearing the output relays MX0 - MX9.

## SELECT

| | LOCAL | EXTERNAL |
|---|---|---|
| (SET)S0 | IN * | OUT |
| (CLEAR) C0 | IN * | OUT |
| S1 | IN * | OUT |
| C1 | IN * | OUT |
| S2 | IN * | OUT |
| C2 | IN * | OUT |
| S3 | IN * | OUT |
| C3 | IN * | OUT |
| S4 | IN * | OUT |
| C4 | IN * | OUT |
| S5 | IN * | OUT |
| C5 | IN * | OUT |
| S6 | IN * | OUT |
| C6 | IN * | OUT |
| S7 | IN * | OUT |
| C7 | IN * | OUT |
| S8 | IN * | OUT |
| C8 | IN * | OUT |
| S9 | IN * | OUT |
| C9 | IN * | OUT |

For example, if S0 is removed on A30 LMI-16 card, then when M90 is programmed, an external acknowledge is required.

If jumper 1-2 is removed (jumper out is the Aerotech standard) and R23 is a 2W 20K resistor, then the acknowledge input is configured for an opto-isolated 115V AC/DC input. (The value of R23 may vary according to input voltage requirements.)

If jumper 1-2 is in and R23 is removed, then the acknowledge is configured for 5V logic input, as illustrated in the diagram below:

| INPUT | JUMPER 1-2 | R23 |
|---|---|---|
| LOGIC | IN | OUT |
| OPTO | OUT * | IN * |

*2. FAULT INPUT (INPUT #2)*

To enable the MST bus fault input, set the appropriate jumper on the CRT board (see chapter 7 of this manual for details).

When jumper 7-8 is inserted (standard), input #2 will be configured as a fault input.

The fault input must be activated (opto input) or pulled low (logic input) or a fault condition will exist that will inhibit the drives and signal Unidex 16 that a fault has occurred.

**TB1-2 is Fault HI**
**TB1-3 is Fault LO**

If jumper 5-6 is removed (jumper out is the Aerotech standard) and R26 is a 2W 20K resistor, then the fault input is configured for an opto-isolated 115V AC/DC input. (The value of R26 may vary according to input voltage requirements.)

If jumper 5-6 is in and R26 is removed, then the fault is configured for 5V logic input, as illustrated in the following diagram:

| INPUT | JUMPER 5-6 | R26 |
|---|---|---|
| LOGIC | IN | OUT |
| OPTO | OUT * | IN * |

**CAUTION: On most systems, input #2 is set up for +12V opto input (jumper 5-6 is out and R26 is a 1K 1/4 Watt resistor). This can be verified by checking card or system documentation.**

*3. HALT INPUT OR CIRQ INPUT (INPUT #2)*

**Halt** To configure this input as a HALT (Halt is a feed-hold), remove 7-8 and jumper 9-10 (make sure 11-12 is removed as well). TB1-2 becomes HALT-HI and TB1-3 becomes HALT-LO. If the input is configured as 5V logic, however, then TB1-2 becomes HALT-N and TB1-3 is not used.

**Cirq** CIRQ is an interrupt input (jumper 11- 12, remove 7-8 and 9-10). TB1-2 becomes CIRQ-HI and TB1-3 becomes CIRQ-LO. If the input is configured as 5V logic, TB1-2 becomes CIRQ-N and TB1-3 is not used.

## E. POWER REQUIREMENTS

### Nominal Values:

+5 V at 50 mA

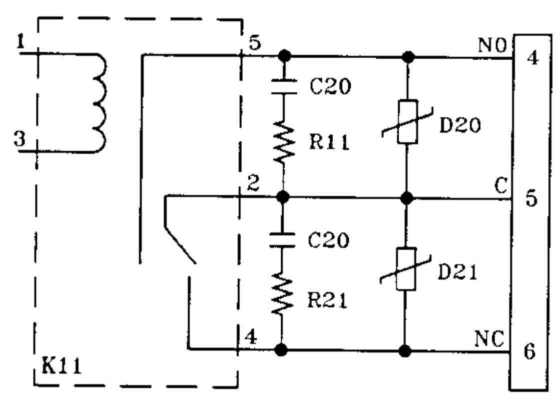
+12 V at 300 mA

**NOTE:** For timing and MST pin-outs, see chapter 9 of this manual.

# F. OUTPUTS

## *1. LATCHED OUTPUTS*

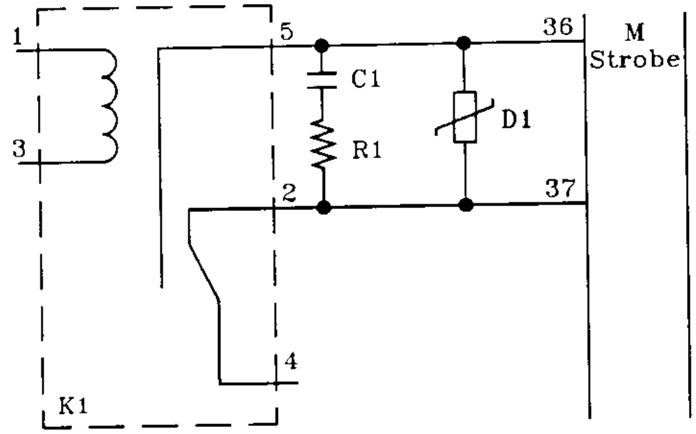
There are 10 latched form "C" relay outputs on the LMI card. See the illustration below for a typical output:




**Contact Rating 5A at 120VAC/28VDC**
**(Resistive Load)**
**All varistors AC 130V (V130LA20A) unless otherwise specified.**

## *2. M-STROBE OUTPUT*

The M-strobe output is unique in that its not latched and provides only the normally open function. The duration of the strobe output will be determined by the M-function parameters (see the *Unidex 16 Motion Controller Programming Manual*, chapter 6).




**(All Resistors 1/2 Watt 220 Ohms)**
**(All Capacitors .1 uF 400 V)**

## G. USER INTERFACE TB1

**LMI-16 CARD RELAY OUTPUTS**
**10 LATCHED FOR "C" AND "M" STROBE**

| * SET/CLEAR | NORMALLY OPEN | WIPER | NORMALLY CLOSED |
|---|---|---|---|
| M90/M80 | TB1-4 | TB1-5 | TB1-6 |
| M91/M81 | TB1-7 | TB1-8 | TB1-9 |
| M92/M82 | TB1-10 | TB1-11 | TB1-12 |
| M93/M83 | TB1-13 | TB1-14 | TB1-15 |
| M94/M84 | TB1-16 | TB1-17 | TB1-18 |
| M95/M85 | TB1-19 | TB1-20 | TB1-21 |
| M96/M86 | TB1-22 | TB1-23 | TB1-24 |
| M97/M87 | TB1-25 | TB1-26 | TB1-27 |
| M98/M88 | TB1-28 | TB1-29 | TB1-30 |
| M99/M89 | TB1-31 | TB1-32 | TB1-33 |
| "M" STROBE | TB1-36 | TB1-38 | NOT USED |

**(Aerotech Standard Jumper Selection)**

## Power Output

TB1-38 +12V (Max 50 mA)
TB1-1 Logic Common

### Inputs

| | Inputs | Opto-isolated | 5v Logic | |
|---|---|---|---|---|
| INPUT #1 | TB1-34 | ACK HI | ACK-N | |
| | TB1-35 | ACK LO | NOT USED | |
| INPUT #2 | TB1-2 | FAULT HI | FAULT | JUMPER |
| | TB1-3 | FAULT LO | NOT USED | 7-8* |
| | TB1-2 | HALT HI | HALT-N | |
| | TB1-3 | HALT LO | NOT USED | 9-10 |
| | TB1-2 | CIRQ HI | CIRQ-N | |
| | TB1-3 | CIRQ LO | NOT USED | 11-12 |

**CAUTION:** *On most systems, input #2 is set up for +12V Opto input (jumper 5-6 is out and R26 is a 1K 1/4 Watt resistor). This can be verified by checking card or system documentation.*

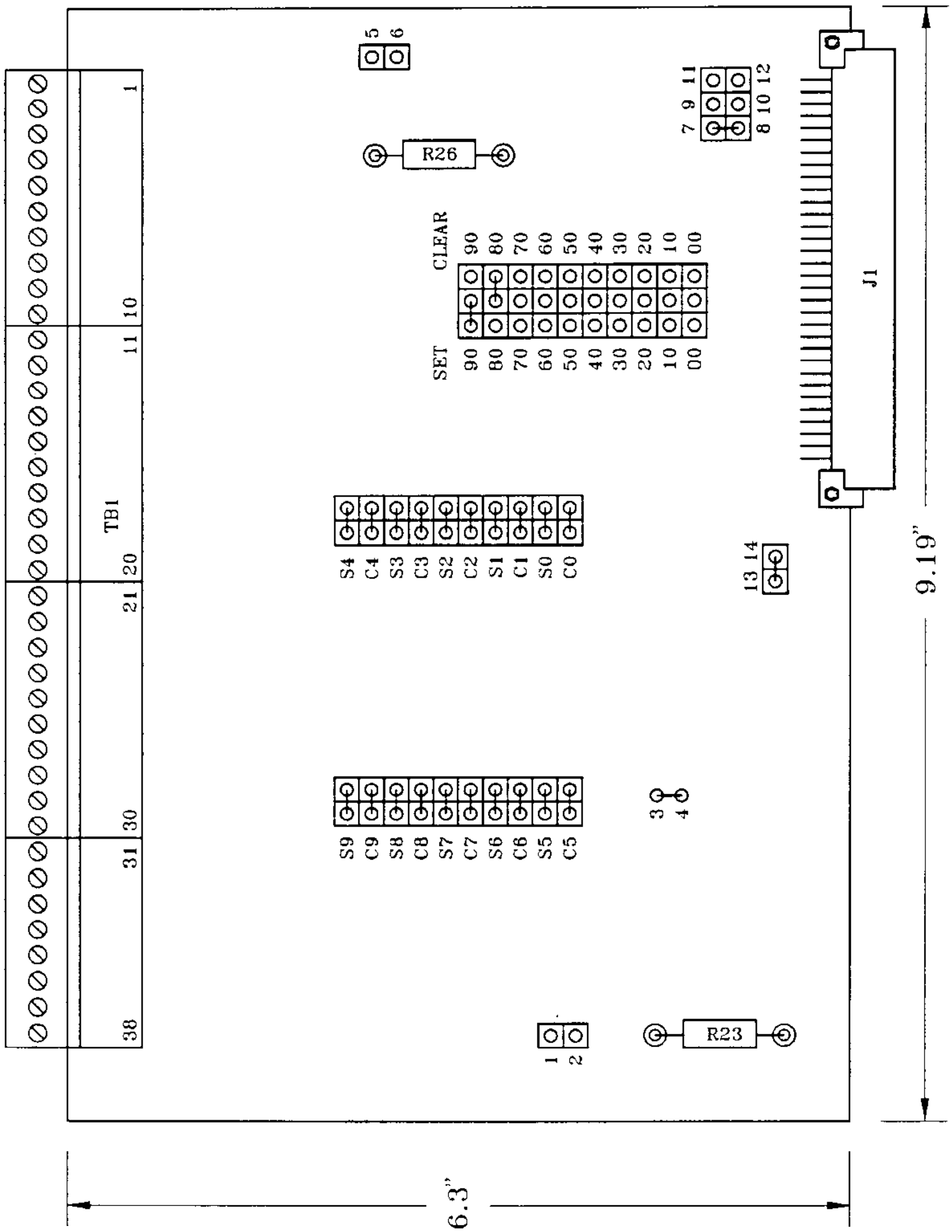



*Figure 10-1: LMI Card*

# SECTION 10-2 TCIO BOARD

Aerotech standards for jumper selections are indicated by an asterisk (*).

The TCIO option is a universal module which provides the following features:

- Four (opto-isolated or logic) inputs to Unidex 16
- Four input-activated interrupts
- Interface for the Opto 22 Pamux 1 card
- Reset circuitry
- Termination for the I/O bus
- Power input to the I/O bus
- Single-high (3U) VME card form factor
- Jumper selection for interrupts
- Jumper selection for interrupt edge sensing

## A. TCIO SPECIFICATIONS

| *CHARACTERISTICS* | *SPECIFICATIONS* |
|---|---|
| **Overall Dimensions:** | |
| Length | 6.95" |
| Width | 3.94" |
| Thickness | 1.35" |
| **Suggested Mating Connectors:** | |
| J1 (I/O Bus) | 3M: 3338-0001 (ECK 355) |
| J2 (Power Supply) | WEIDMULLER: 5528.6 (ECK 519)* |
| J3 (User Inputs) | 3M: 3399-6026 (ECK 343)* |

| | |
|---|---|
| J4 (Opto 22 Interface) | 3M: 3425-6050 (ECK 332) |

*** Connector Supplied**

| | |
|---|---|
| Power Requirements | 5V @ 375 mA (Typical) |

### Inputs:

| | |
|---|---|
| Opto Isolated<br>or<br>5V Logic | 5V @ 20 mA<br><br>CMOS Input With 7K Pull-up |
| Debounce | Typical 15 - 20 mS ** |

## B. OPERATION OF THE TCIO CARD

### *1. INPUT JUMPERS JP4*

The input can be configured as an opto isolated type (standard) or as a 5V logic type (jumper selectable).

### JP4

### Input #1

| JUMPER 1-2 | R1 | |
|---|---|---|
| IN | OUT | Logic input |
| OUT | IN | * Opto isolated input |

### Input #2

| JUMPER 3-4 | R2 | |
|---|---|---|
| IN | OUT | Logic input |
| OUT | IN | * Opto isolated input |

## Input #3

| JUMPER 5-6 | R3 | |
|---|---|---|
| IN | OUT | Logic input |
| OUT | IN | * Opto isolated input |

## Input #4

| JUMPER 7-8 | R4 | |
|---|---|---|
| IN | OUT | Logic input |
| OUT | IN | * Opto isolated input |

The value of R1 - R4 will vary according to input voltage requirements. (Standard is 5V opto isolated input. R is a 120 ohm, 1/4 watt resistor.)

If configured as an opto isolated input, the input will be activated and the LED will light when 20 mA of current is flowing through the opto coupler.

If configured as a 5V logic-N input, then the input will be activated when pulled low.

Because the TCIO board employs a debounce circuit, the input must remain actuated for at least 20mS or the input (and/or interrupt) cannot be read. If, however, interfacing with high speed logic is required, the value of C1 can be changed to allow for minimum debouncing.

In order to read the 4 inputs, Unidex 16 will read the first 4 bits of the Input/Interrupt Status Register. An input is indicated when the appropriate bit is set high. The Input/Interrupt Status Register is always located at address $780. The second 4 bits are designated as the interrupt flags.

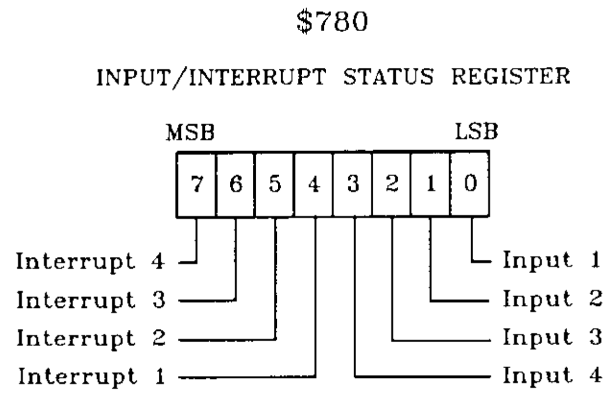



DIAGRAM 1

## 2. *INTERRUPTS*

The Unidex 16 I/O bus has 4 interrupts which are shared by all I/O modules. On the TCIO board, these 4 interrupts are accessed via the 4 inputs. Each interrupt line has a certain priority, INT4 having the highest priority, INT1 having the lowest.

The interrupt lines are used to interrupt Unidex 16 while it is performing another task. An interrupt is generated when a change in voltage level is detected (as opposed to an input, which detects a voltage level).

When an input is activated, the corresponding interrupt flag will be set and the interrupt line will be held low by the TCIO board until that flag is cleared by Unidex 16 by reading or writing to the appropriate TCIO address (see table below).

| TCIO Address | Interrupt Flag |
|---|---|
| $790 | Interrupt flag 1 |
| $7A0 | Interrupt flag 2 |
| $7B0 | Interrupt flag 3 |
| $7C0 | Interrupt flag 4 |

**Interrupt Flag Output**

In addition to the internal functions of the interrupt flags, each flag provides an output and LED indicator as well. The output allows the user to see when an interrupt flag has been set as well as when its been cleared.

The output is available through an optical isolator (Motorola 4N33).

Because the interrupt lines are shared by all I/O modules, one of the first tasks performed by Unidex 16 upon receiving an interrupt is to determine which module generated the interrupt. By reading the Input/Interrupt Status Register, Unidex 16 can determine if the TCIO board generated the interrupt by checking to see if any of the bits are set (see diagram 1).

The Status Register check and the clearing of the interrupt flags must be generated by the user's program.

Please refer to the *Unidex 16 Motion Controller Programming Manual* for details on interrupt types and options.

## Interrupt Active Jumper JP2

Each of the inputs can be used to activate an interrupt when the appropriate jumper is installed in header JP2.

## JP2

## Input #1

| JUMPER 1-2 | |
|---|---|
| IN* | Interrupt #1 active |
| OUT | Input only |

## Input #2

| JUMPER 3-4 | |
|---|---|
| IN * | Interrupt #2 active |
| OUT | Input only |

## Input #3

| JUMPER 5-6 | |
|---|---|
| IN * | Interrupt #3 active |
| OUT | Input only |

## Input #4

| JUMPER 7-8 | |
|---|---|
| IN * | Interrupt #4 active |
| OUT | Input only |

When an input is activated, the corresponding interrupt flag will be set and the interrupt line will be held low by the TCIO board. It will be held low until that flag is cleared by Unidex 16 by reading or writing to the appropriate TCIO address (see table below).

| TCIO ADDRESS | INTERRUPT FLAG |
|---|---|
| $790 | Interrupt flag 1 |
| $7A0 | Interrupt flag 2 |
| $7B0 | Interrupt flag 3 |
| $7C0 | Interrupt flag 4 |

Because the interrupt lines are shared by all I/O modules, one of the first tasks performed by Unidex 16 upon receiving an interrupt will be to determine which module generated the interrupt. By reading the Input/Interrupt Status Register, Unidex 16 can determine if the TCIO board generated the interrupt by checking to see if any of the bits are set (see diagram 1).

The Status Register check and the clearing of the interrupt flags must be generated by the user's program.

## Interrupt Edge Jumpers JP3

Interrupts can be generated when inputs are activated (+ edge) or deactivated (- edge). This will be determined by header JP3 as shown next:

### JP3

### Input #1 - Interrupt #1

| JUMPER 1-2 | |
|---|---|
| IN * | + Edge |
| OUT | - Edge |

### Input #2 - Interrupt #2

| JUMPER 3-4 | |
|---|---|
| IN * | + Edge |
| OUT | - Edge |

### Input #3 - Interrupt #3

| JUMPER 5-6 | |
|---|---|
| IN * | + Edge |
| OUT | - Edge |

### Input #4 - Interrupt #4

| JUMPER 7-8 | |
|---|---|
| IN * | + Edge |
| OUT | - Edge |

In addition to the internal functions of the interrupt flags, each flag provides an output and LED indicator as well. The output allows the user to see when an interrupt flag has been set as well as when its been cleared.

The output is available through an optical isolator (Motorola 4N33).

### 3. *OPTO 22 PAMUX 1 INTERFACE*

The interface between the TCIO card and one or more Opto 22 cards is provided through J4. J4 is a 50 pin ribbon cable connector that is pin for pin compatible with Opto 22 Pamux 1 (PB16P1).

The Opto 22 Pamux 1 is a flexible I/O system which can accommodate up to 16 plug-in I/O modules of AC inputs, DC inputs, AC outputs, DC outputs or any combination of the above.

Each Opto 22 Pamux 1 board has 2 (8-bit) bytes of data, each bit corresponding to one I/O module, and is provided with an address switch. An address ranging from $700 to $77F may be selected. When the address switch for one Opto 22 board is set to a certain address, for example $700, the first 8 modules are assigned to this address. Automatically, the second 8 modules are assigned to the next address (in this case $701).

To select addresses, see the following diagram.

**OPTO 22 PAMUX 1**

| Opto 22 Pamux 1 | Address Switches | Address | Modules | Address | Modules |
|---|---|---|---|---|---|
| | 654321 | | | | |
| A47(A) | CCCCCC | $700 | 0-7 | $701 | 8-15 |
| A47(B) | CCCCCO | $702 | 0-7 | $703 | 8-15 |
| . | . | . | . | . | . |
| . | . | . | . | . | . |
| | OOOOOO | $77E | 0-7 | $77F | 8-15 |

C = CLOSED
O = OPEN

**NOTE:** *Terminating resistors on the last Pamux 1 Board Only. Remove All Others.*

*4. RESET JUMPER JP1*

The TCIO card is provided with reset option circuitry. Within this circuitry, there is a jumper provided for the interrupt flags and one for the Opto 22 interface.

If the Unidex 16 <RESET> is to have no effect on the interrupt flags or on the Opto 22 Pamux 1 board, the jumper (JP1) applicable to either or both may be removed.

## JP1

| JUMPER 1-2 | |
|---|---|
| IN * | Unidex 16 <RESET> active: will reset interrupt flags |
| OUT | Unidex 16 <RESET> inactive: will not reset interrupt flags |

| JUMPER 3-4 | |
|---|---|
| IN * | Unidex 16 <RESET> active: will reset Opto 22 Pamux 1 board |
| OUT | Unidex 16 <RESET> inactive: will not reset Opto 22 Pamux 1 board |

### *5. BUS TERMINATION*

The TCIO board provides adequate termination for the I/O bus. All of the address lines, data lines and clock lines are terminated with a 330 ohm pull-up resistor and a 470 ohm pull- down resistor.

### *6. POWER INPUTS J2*

The J2 connector on the TCIO card provides the DC power connections to run not only the TCIO card but also provides power for the rest of the modules on the I/O bus, as well.

When no auxiliary power supply is required, the TCIO board will be powered through the ribbon cable wiring of the I/O bus. When an auxiliary power supply is required for more I/O capacity, then the I/O bus will be powered via the J2 connector.

### *7. INPUT DEBOUNCE*

The TCIO board's debounce circuitry is provided by M12 (4490). As mentioned previously, the standard value of C1 is .0047 µf, which provides for a debounce period of between 15 to 20 mS. The debounce period may be changed by varying C1. The following chart gives examples of this.

**Debounce**

| C1 | CL | Debounce Period |
|---|---|---|
| .0047µf | 4.0mS (x4) | 16mS (±10%, - 1CL) |
| 50pf | 50µS (x4) | 200µS (±10%, - 1CL) |

To bypass the debounce circuitry, remove M12 and insert a 16 pin DIP plug (AUGAT Part #616-DG-5 or equal) and insert the following jumpers into the plug:

| Jumper |
|---|
| 1 - 15 |
| 2 - 14 |
| 3 - 13 |
| 4 - 12 |

## *8. USER INTERFACE*

### J1 - I/O BUS INTERFACE

| PIN# | FUNCTION | PIN# | FUNCTION |
|---|---|---|---|
| C1 | INT4-N | A1 | COMMON |
| C2 | INT3-N | A2 | COMMON |
| C3 | INT2-N | A3 | COMMON |
| C4 | INT1-N | A4 | COMMON |
| C5 | IORES-N | A5 | COMMON |
| C6 | XACK-N | A6 | COMMON |
| C7 | CLOCK | A7 | COMMON |
| C8 | RESERVED | A8 | COMMON |
| C9 | RESERVED | A9 | COMMON |
| C10 | RESERVED | A10 | COMMON |
| C11 | COMMON | A11 | A11 |
| C12 | A9 | A12 | A10 |
| C13 | A7 | A13 | A8 |
| C14 | A5 | A14 | A6 |
| C15 | A3 | A15 | A4 |
| C16 | A1 | A16 | A2 |
| C17 | A0 | A17 | COMMON |
| C18 | STB-N | A18 | COMMON |
| C19 | R/W | A19 | COMMON |
| C20 | COMMON | A20 | D7 |
| C21 | D5 | A21 | D6 |
| C22 | D3 | A22 | D4 |
| C23 | D1 | A23 | D2 |
| C24 | D0 | A24 | COMMON |
| C25 | COMMON | A25 | COMMON |
| C26 | -12V | A26 | -12V |
| C27 | RESERVED | A27 | RESERVED |
| C28 | +12V | A28 | +12V |
| C29 | +5V | A29 | +5V |
| C30 | +5V | A30 | +5V |
| C31 | COMMON | A31 | COMMON |
| C32 | COMMON | A32 | COMMON |

## J2 - POWER SUPPLY

| PIN# | FUNCTION |
|---|---|
| 1 | +12V |
| 2 | +5V |
| 3 | SIG COM |
| 4 | -12V |

## J3 - INPUTS/INTERRUPT FLAG OUTPUTS

| PIN# | FUNCTION |
|---|---|
| 1 | COMMON |
| 2 | IP1+ (Input #1) |
| 3 | IP1- |
| 4 | COM |
| 5 | IP2+ |
| 6 | IP2- |
| 7 | COMMON |
| 8 | IP3+ |
| 9 | IP3- |
| 10 | COMMON |
| 11 | IP4+ |
| 12 | IP4- |
| 13 | COMMON |
| 14 | INT1+ (Interrupt flag output) |
| 15 | INT1- |
| 16 | COMMON |
| 17 | INT2+ |
| 18 | INT2- |
| 19 | COMMON |
| 20 | INT3+ |
| 21 | INT3- |
| 22 | COMMON |
| 23 | INT4+ |
| 24 | INT4- |
| 25 | COMMON |
| 26 | +5V (50 mA) |

## J4 - OPTO 22 PAMUX 1 INTERFACE

| PIN# | FUNCTION |
|---|---|
| 1 | A7-N |
| 2 | SIG COM |
| 3 | A6-N |
| 4 | SIG COM |
| 5 | A5-N |
| 6 | SIG COM |
| 7 | A4-N |
| 8 | SIG COM |
| 9 | A3-N |
| 10 | SIG COM |
| 11 | A2-N |
| 12 | SIG COM |
| 13 | A1-N |
| 14 | SIG COM |
| 15 | A0-N |
| 16 | SIG COM |
| 17 | RESERVED |
| 18 | SIG COM |
| 19 | RESERVED |
| 20 | SIG COM |
| 21 | W-N |
| 22 | SIG COM |
| 23 | R-N |
| 24 | SIG COM |
| 25 | RESERVED |
| 26 | SIG COM |
| 27 | RESERVED |
| 28 | SIG COM |
| 29 | RESERVED |
| 30 | SIG COM |
| 31 | RST-N |
| 32 | SIG COM |
| 33 | D7-N |

| PIN# | FUNCTION |
|---|---|
| 34 | SIG COM |
| 35 | D6-N |
| 36 | SIG COM |
| 37 | D5-N |
| 38 | SIG COM |
| 39 | D4-N |
| 40 | SIG COM |
| 41 | D3-N |
| 42 | SIG COM |
| 43 | D2-N |
| 44 | SIG COM |
| 45 | D1-N |
| 46 | SIG COM |
| 47 | D0-N |
| 48 | SIG COM |
| 49 | RESERVED |
| 50 | SIG COM |

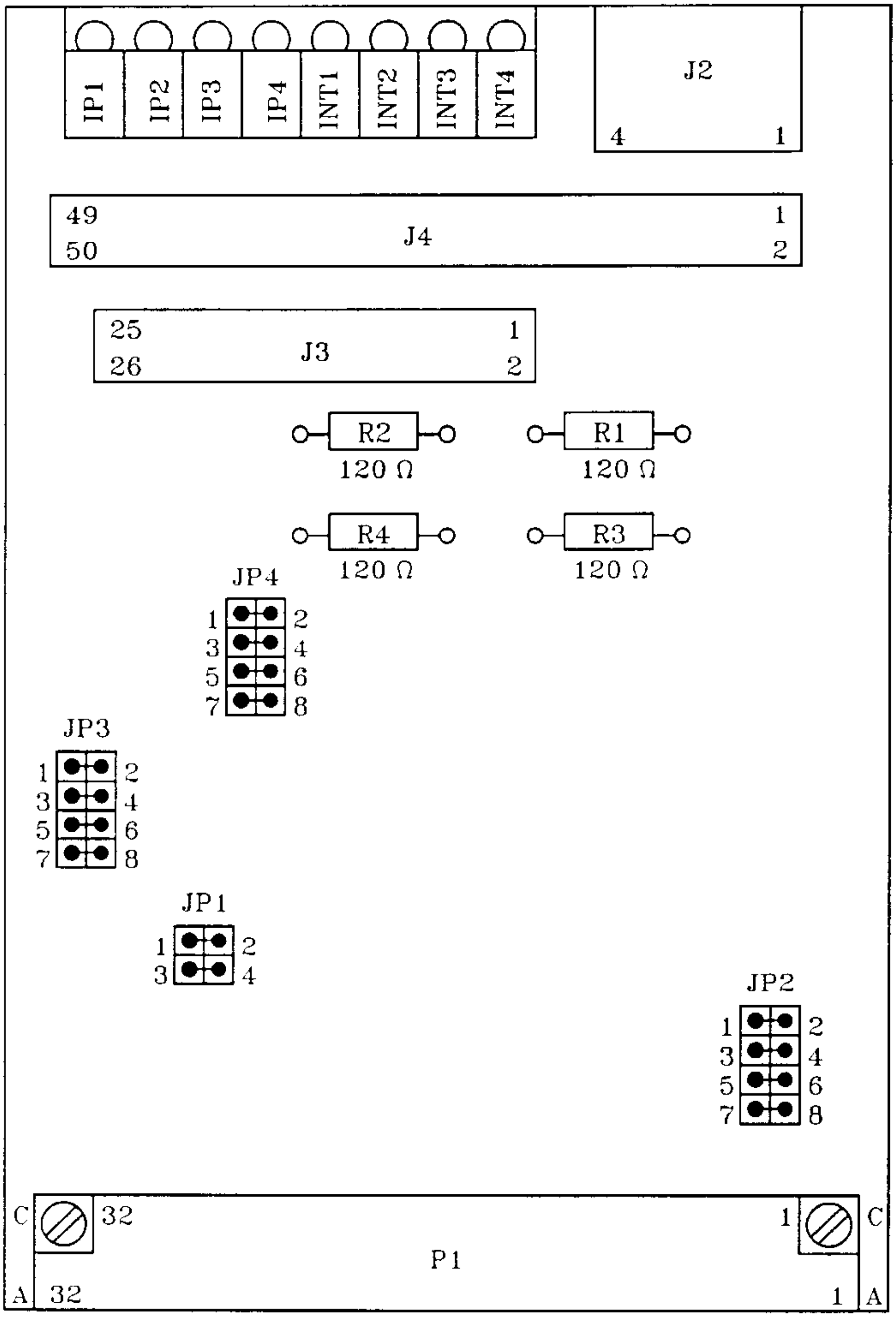


*Figure 10-2: TCIO BOARD*

## SECTION 10-3 USER'S FREE RUN OPTION (SFR)

The User Free-Run Card allows one of the six axes to be run in a spindle mode. Once the speed is programmed by means of the "S" commands, the "M" functions are used to turn the option off and on, and to change directions.

The User Free-Run Card plugs into one of the spare slots of the Unidex 16 Card Cage, A9. Because the free run board does not use the acknowledge and fault signals of Unidex 16, the appropriate switches on the Unidex 16 mother board must be used to bypass the free-run board (see section 7-1).

Although there are no jumper changes required on the User Free-Run Board itself, the indexing board that is used with this option must be configured properly (see section 7-4).

The associated parameters and commands are as follows:

1. Parameter 420, spindle type, must be set at 3.
2. Parameter 450, normal M functions, must be set at 0, 2 or 3.
3. Parameter 451, normal S functions, must be set at 0, 2 or 3.
4. User program will specify free run speed using an S command.
5. MSO can adjust speed in 0% - 200% range.
6. (UMSO, <option>) can disable MSO.
7. Command M32 - Turn CW on.
8. Command M33 - Turn CCW on.
9. Command M34/ or system Reset - Turn off.

## A. APPLICATION

Without M32/M33, the specified axis can contour as usual (act as the other axes).

Before turning on the user's free run option with an M32 or M33 command, *it is very important to set the speed with a speed command (Sxxxxx) first.* This will guarantee that the free-run is set at a desirable and safe speed.

Sxxxxx: Where S is the speed command, and xxxxx is a number between 1 and 65535 (parameters 422 and 430 set this range). Based on this information, Unidex 16 will send out the free run clock rate, based on the formula:

**750 KC * xxxxx/65535**

Once the free-run starts, you can change the speed (Sxxxxx) or direction (M32/M33).

If you must turn OFF the free run option (M34), and then turn it on again (M32/M33), the previous speed is still in effect.

# SECTION 10-4 BINARY OUTPUT OPTION

**NOTE:** Aerotech standards for jumper selections are indicated by an asterisk (*).

The binary output option is dedicated to providing the actual positions of the axes, on the fly, when requested to do so by the user's host computer.

The binary output option is dedicated to providing the actual positions of the axes, on the fly, when requested to do so by the user's host computer.

The binary output board will plug into the Unidex 16 Versabus card cage. It provides the actual position of each axis by counting the feedback clock pulses coming from the indexing board, latching the data, and outputting it via a 16 bit high- speed parallel bus. It can handle the positions of 6 axes, one of which may be a free-run axis.

The binary output board also features the following:

- Unidex 16 Versabus compatible
- Compatible with DEC DRV-11J I/O Interface
- Counter information which can be latched and output at any time.
- Address selection for output of each axis
- Individual axis reset via Unidex 16 I/O Channel
- Jumper selection for one free-run (rotary) axis
- Remote readout display option
- For rotary axis, switch select "once per revolution" reset on both the + and - direction
- Remote display interface, a 50 pin connector, can interface to Aerotech's Read-out Module.

## A. SPECIFICATIONS

| *CHARACTERISTICS* | *SPECIFICATIONS* |
|---|---|
| **Overall Dimensions:** | |
| | Standard Versabus size |
| Length | 14.50" |
| Width | 9.25" |

**Power Requirements:**

| | |
|---|---|
| Binary Output Board | +5V @ 1.0A |
| Buffered Readouts | +12V @ 1.5A (250mA/axis display) |

**Suggested Mating Connectors:**

| | |
|---|---|
| J3 - 50 Pin connector (to host computer) | FLAT CABLE CONNECTOR, 3M PN 3564-1001 (or equivalent) |

**or**

| | |
|---|---|
| J4 - 50 Pin connector (to remote readout) | ROUND CABLE CONNECTOR, Amp Champ Connector 552032-1 and associated |
| J5 - 50 Pin connector (to Unidex 16 I/O bus) | 90 Strain Relief 552731-1 or equivalent |

**J3 User Interface:**

| | |
|---|---|
| Inputs | 1 LS TTL Load |
| Outputs | Tri State LS TTL 74LS244 |
| Output Enable-N | 4 LS TTL Loads |

**J4 Serial Output:**

| | |
|---|---|
| Readout Interface | High-Speed CMOS 74HC240 |

| | |
|---|---|
| **J5 Unidex 16 I/O bus Interface:** | See chapter 9 |
| Maximum Data Rate: | 500KHz |
| Max data rate of Unidex 16 system: | 125KHz |
| Max data rate of Unidex 16 system Free-Run option | 160KHz |

## B. OPERATION OF BINARY OUTPUT BOARD

### *1. LATCH ADDRESSING METHODS AND DATA FORMAT*

The design of the Binary Output, as well as the pin-out, addressing, data format and latching, are based on the DEC DRV- 11J I/O interface (see table 10-1). The protocol for the Binary Output Board is an asynchronously addressed polling with an output enable, and high and low data words (16 bit + 8 bit = 24 bit, + 8 bit sign = 32 bit total). The latch lines are tied directly to I/O interface address lines and are active lows. (See table 10-1 for the pin-out.)

By taking the proper address lines low, the corresponding axis position at that moment can be latched and read at some future time.

That information will remain there until the latch is taken low again, at which time a new current position is loaded into the buffer.

**NOTE:** The latch pulse must be a minimum of 250nS. (See table 10-1 for tolerances.)

Polling the buffers is done by means of addressing them using A0, A1 and A2 (see table 10-1 for pin-out) and toggling A3 for the high or low data words. Output Enable is required as well.

The data format is a 2's complement binary read-out in high and low data words (16 bits each) for a total of 32 bits, but only 24 are used for data. The 8 MSB duplicate the sign bit.

### *2. DIRECTION JUMPERS*

Direction jumpers are supplied on the Binary Output board in order to allow the user to choose the desired direction. A direction change will change what is represented in the Binary Output board counter.

*The direction jumpers have no effect on motor rotation.* Motor rotation is determined by jumpers on the indexing board (refer to section 7-4 of this manual) and parameter selections (refer to chapter 6 of the *Unidex 16 Motion Controller Programming Manual*).

The Aerotech standard direction is a positive move, indicating CW motor rotation, (as viewed from the mounting flange end of motor).

| AXIS | JUMPER | CW = POSITIVE COUNT | CCW = POSITIVE COUNT |
|---|---|---|---|
| X | JP12 | 1-2 3-4 | 1-3 2-4 |
| Y | JP11 | 1-2 3-4 | 1-3 2-4 |
| Z | JP10 | 1-2 3-4 | 1-3 2-4 |
| U | JP9 | 1-2 3-4 | 1-3 2-4 |
| V | JP8 | 1-2 3-4 | 1-3 2-4 |
| W | JP7 | 1-2 3-4 | 1-3 2-4 |

*3. LINEAR/ROTARY TRAVEL SELECTION JUMPERS*

**Addressing and Steering Jumpers**

All six axes may move in a linear fashion, or one axis may be selected for rotary travel while the other five travel linearly.

The jumper group for each axis is provided in a Dual Inline Package (see the following diagram).

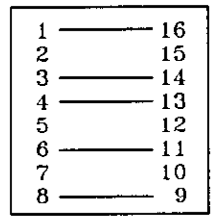
The following jumper group is representative of the one designated for each axis. The axis to which each applies is marked on the silk screen of the Binary Output Card.

LINEAR

JUMPER

1-16 *
3-14 *
4-13 *
6-11 *
8-9 *

DIP

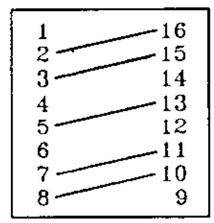



ROTARY

JUMPER

2-16 *
3-15 *
5-13 *
7-11 *
8-10 *

DIP




## Rotary Axis Latching Jumper

In addition to the above mentioned DIP jumper changes for the rotary axis, the appropriate data latching jumper must also be selected:

| | | ROTARY | LINEAR |
|---|---|---|---|
| X AXIS | JP1 | 1-2 | 2-3* |
| Y AXIS | JP2 | 1-2 | 2-3* |
| Z AXIS | JP3 | 1-2 | 2-3* |
| U AXIS | JP4 | 1-2 | 2-3* |
| V AXIS | JP5 | 1-2 * | 2-3 |
| W AXIS | JP6 | 1-2 | 2-3* |

### *4. REMOTE DISPLAY RESET JUMPERS*

A binary output that displays linear travel requires a reset only when the system is reset. Rotary travel, however, requires a once-per-rev reset, since degrees of rotation rather than linear travel is being displayed.

The type of reset required is jumper selectable. The reset jumper pertaining to each axis is listed below:

| AXIS | JUMPER | LINEAR RESET * | ROTARY RESET (1 axis only) |
|---|---|---|---|
| X | JP13 | 2-3 | 1-2 |
| Y | JP14 | 2-3 | 1-2 |
| Z | JP15 | 2-3 | 1-2 |
| U | JP16 | 2-3 | 1-2 |
| V | JP17 | 2-3 | 1-2 |
| W | JP18 | 2-3 | 1-2 |

*5. RESET*

The reset of the counter(s) may happen by one of four methods:

**System Reset**

This method resets all boards in the Unidex 16 system. It will reset all counters and support circuitry on the binary output board.

**Home Reference**

Home reference reset occurs whenever an axis is "sent home" on the binary output board. This will reset only the counter related to that axis.

**Rotary Table**

This is a periodic reset. Due to the cyclic nature of the free- run axis, a reset of the free-run counter is required after every rotation. The cycle is determined by the resolution of the system and the user's needs and is controlled by the DIP switch settings on the Binary Output Board.

There are two banks of DIP switches on the board – one for the positive direction of rotation and one for the negative. The format for the position setting of the switches is binary 2's complement. The negative switch bank must be the 2's complement of the positive switch bank.

| **MSB** | | **LSB** | | |
|---|---|---|---|---|
| SW4 | SW5 | SW6 | → | Positive Value |
| SW1 | SW2 | SW3 | → | Negative Value |

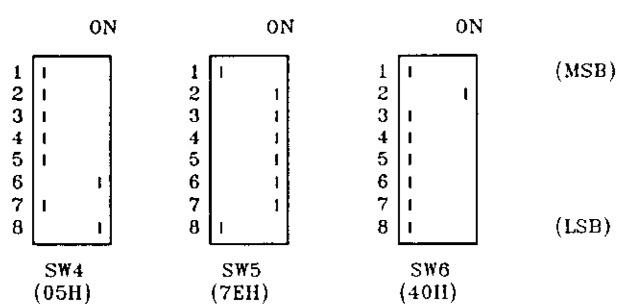
For example:

**Set Once-per-rev Switch SW1 → SW6**

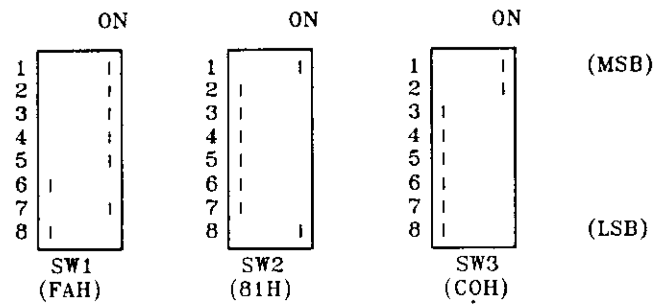
*a)* Determine the machine steps for 1 revolution of a rotary table. Here we will assume it is 360000.

*b)* Change: 360000 (Decimal Format) into: 057E40 (Hexadecimal Format)

This is the data set into SW4, SW5 and SW6:




*c)* Then find the negative data (2's complement) of 057E40 (HEX), which is FA81C0 (HEX). This is the data set into SW1, SW2 and SW3:




### I/O Bus

The axis counters on the board may be reset in unison, individually or in any combination, via the I/O bus. (Refer to chapter 9 of this manual.)

Writing to address 6FF in hexadecimal, using the Unidex 16 format \$6FF = H,nn, resets the desired axis counters.

**NOTE:** Resetting the binary output board by use of the I/O bus does not reset the axis or anything pertaining to it within the Unidex 16 system.

| | |
|---|---|
| | D7D6D5D4 D3D2D1D0 |
| Sending \$6FF accesses | |*|*|W|V||U|Z|Y|X| |

To reset the Binary Output Board via the I/O bus, write:

\$6FF = H,nn (nn represents the byte of reset information being sent to the Binary Output Board. A zero is sent to reset the axes counters.)

For example:

\$6FF = H,12 would send out |0|0|0|1||0|0|1|0|

and would reset the W, U, Z AND X counters.

**NOTE:** All of these conditions are true for the remote display as well.

## C. REMOTE DISPLAY

This option requires the remote display hardware. The signals provided at the connector are the CW and CCW feedback pulses from the drives as well as the reset signal for each axis. If one of the axes is used as a rotary table, that axis reset jumper must be changed accordingly, via J4. The reset signals are taken from the Binary Output Board counters and therefore will respond as the Binary Output Board does (see subsection B5, RESET, of this section).

**NOTE:** The pinout for J4 is listed on the following page.

**J4**

| PIN # | SIGNAL NAME | PIN # | SIGNAL NAME |
|---|---|---|---|
| 1 | (-)X CL-N | 26 | + X CL-N |
| 2 | X RESET-N | 27 | COMMON |
| 3 | (-)Y CL-N | 28 | + Y CL-N |
| 4 | Y RESET-N | 29 | COMMON |
| 5 | (-)Z CL-N | 30 | + Z CL-N |
| 6 | Z RESET-N | 31 | COMMON |
| 7 | (-)U CL-N | 32 | + U CL-N |
| 8 | U RESET-N | 33 | COMMON |
| 9 | (-)V CL-N | 34 | + V CL-N |
| 10 | V RESET-N | 35 | COMMON |
| 11 | (-)W CL-N | 36 | + W CL-N |
| 12 | W RESET-N | 37 | COMMON |
| 13 | COMMON | 38 | COMMON |
| 14 | COMMON | 39 | COMMON |
| 15 | COMMON | 40 | COMMON |
| 16 | COMMON | 41 | COMMON |

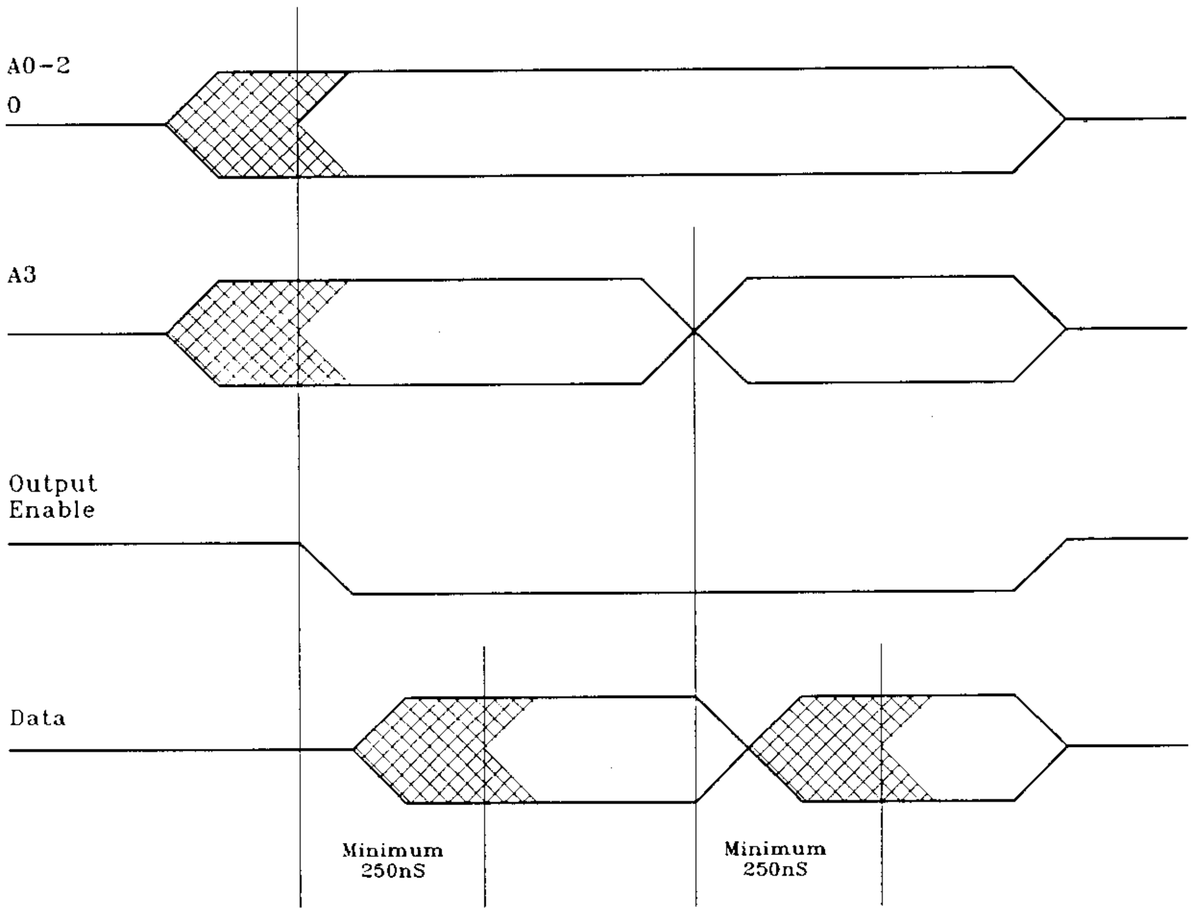
**J4 PINOUT**

Unidex 16 Binary Position Output to DEC[TM] DRV11-J Interface Wiring

DRV11-J | UNIDEX 16

| WIRE# | DEC SIGNAL | DIRECTION | TERMINATION | BUFFERED | AEROTECH SIGNAL NAME LOW WORD/HIGH WORD | ACTIVE H/L |
|---|---|---|---|---|---|---|
| 1 | B-0 (DATA) | ← | T | B | 1 2~16 | H |
| 2 | B-1 (DATA) | ← | T | B | 2 2~17 | H |
| 3 | B-2 (DATA) | ← | T | B | 4 2~18 | H |
| 4 | B-3 (DATA) | ← | T | B | 8 2~19 | H |
| 5 | B-4 (DATA) | ← | T | B | 16 2~20 | H |
| 6 | B-5 (DATA) | ← | T | B | 32 2~21 | H |
| 7 | B-6 (DATA) | ← | T | B | 64 2~22 | H |
| 8 | B-7 (DATA) | ← | T | B | 128 2~23 | H |
| 9 | B-8 (DATA) | ← | T | B | 256 | H |
| 10 | B-9 (DATA) | ← | T | B | 512 | H |
| 11 | B-10 (DATA) | ← | T | B | 1024 | H |
| 12 | B-11 (DATA) | ← | T | B | 2048 | H |
| 13 | B-12 (DATA) | ← | T | B | 4096 | H |
| 14 | B-13 (DATA) | ← | T | B | 8192 | H |
| 15 | B-14 (DATA) | ← | T | B | 16384 | H |
| 16 | B-15 (DATA) | ← | T | B | 32768 | H |
| 17 | GND | — | | | GND | |
| 18 | USER B READY | ← | T | | SIGN - Always High | H=+ |
| 19 | GND | — | | | GND | |
| 20 | USER B REPLY | ← | | | GND | |
| 21 | GND | — | | | GND | |
| 22 | DRV11-J B READY | → | T | | OUTPUT ENABLE | L |
| 23 | GND | — | | | GND | |
| 24 | DRV11-J B REPLY | → | | | NO CONNECTION | |
| 25 | GND | — | | | NO CONNECTION | |
| 26 | GND | — | | | NO CONNECTION | |
| 27 | DRV11-J A REPLY | → | | | NO CONNECTION | |
| 28 | GND | — | | | GND | |
| 29 | DRV11-J A READY | → | | | NO CONNECTION | |
| 30 | GND | — | | | GND | |
| 31 | USER A REPLY | ← | | | GND | L |
| 32 | GND | — | | | GND | |
| 33 | USER A READY | ← | | | GND | L |
| 34 | GND | — | | | GND | |
| 35 | A-15 | → | | | NO CONNECTION | |
| 36 | A-14 | → | T | B* | NO CONNECTION | |
| 37 | A-13 | → | T | B* | X DATA LATCH | L |
| 38 | A-12 | → | T | B* | Y DATA LATCH | L |
| 39 | A-11 | → | T | B* | Z DATA LATCH | L |
| 40 | A-10 | → | | | U DATA LATCH | L |
| 41 | A-9 | → | T | B* | V DATA LATCH | L |
| 42 | A-8 | → | T | B* | W DATA LATCH | L |
| 43 | A-7 | → | | | NO CONNECTION | |
| 44 | A-6 | → | | | NO CONNECTION | |
| 45 | A-5 | → | | | NO CONNECTION | |
| 46 | A-4 | → | | | NO CONNECTION | |
| 47 | A-3 | → | T | B* | ADDRESS BIT 3 | H |
| 48 | A-2 | → | T | B* | ADDRESS BIT 2 | H |
| 49 | A-1 | → | T | B* | ADDRESS BIT 1 | H |
| 50 | A-0 | → | T | B* | ADDRESS BIT 0 | H |

*Table 10-1: Specifications*




Address and Output Enable to
Valid Data is 250nS

Minimum Pulse Width is 100nS

*Figure 10-3: Timing Diagram for the Binary Output Board*

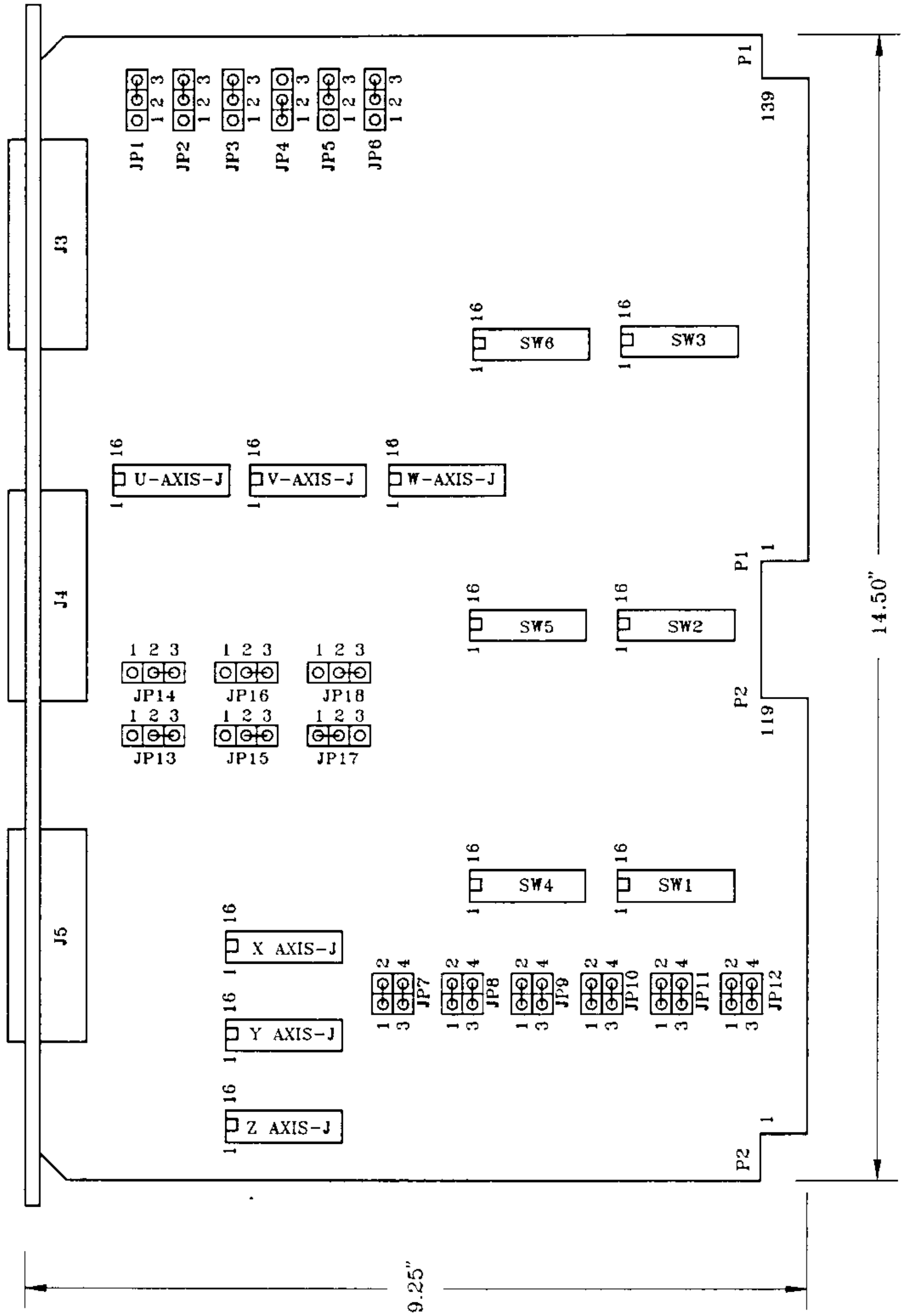



*Figure 10-4: Binary Output Board*

# SECTION 10-5 FRONT PANEL OPTO INTERFACE BOARD

**NOTE:** The Aerotech standard for a jumper selection is indicated by an asterisk (*).

The Front Panel Opto Interface Board allows the user to remotely access any ten of the front panel keys.

Isolation is accomplished by opto isolated inputs (Motorola 4N33) and an isolated power supply.

The opto interface board bolts onto the back of the Unidex 16 front panel board. The front panel membrane plugs into it and the opto interface board opto couplers parallel the front panel key closures. This assembly then plugs into the front panel board.

The opto interface board provides the following features:

- Opto isolation
- Remote access of up to ten Unidex 16 front panel keys
- Isolated power supply
- Matrix jumper selection of remote keys

## A. OPTO INTERFACE SPECIFICATIONS

| Characteristics | Specifications |
|---|---|
| **Overall Dimensions:** | |
| Depth | 5.125 Inches |
| Width | 6.50 Inches |
| Thickness | 1.00 Inch |

**Suggested Mating Connectors:**

| | |
|---|---|
| P2 | 3M3399-6026 * |
| FP-P1 | TRW DB25P (connector) * |
| | TRW DB24659 (backshell) * |
| | TRW D 20419-16 (screw lock assy) * |

* *Supplied with System*

**Power Requirements:**

| | |
|---|---|
| Input | 5V @ 20mA (standard) |
| Isolated Power Supply Output | 5V @ 660mA (standard) or unregulated 14V @ 1.3 Amps |

## B. OPERATION OF THE OPTO INTERFACE BOARD

### *1. JUMPER SELECTION OF KEYS*

To select a key to be one of the ten remote keys, two jumpers must be inserted into the Opto Interface Board Matrix. Front panel keys and their corresponding jumpers can be found in figure 10-5. To determine the correct X and Y jumpers for a particular key selection, trace upward to find the correct Xn jumper and trace across to find the correct Yn jumper.

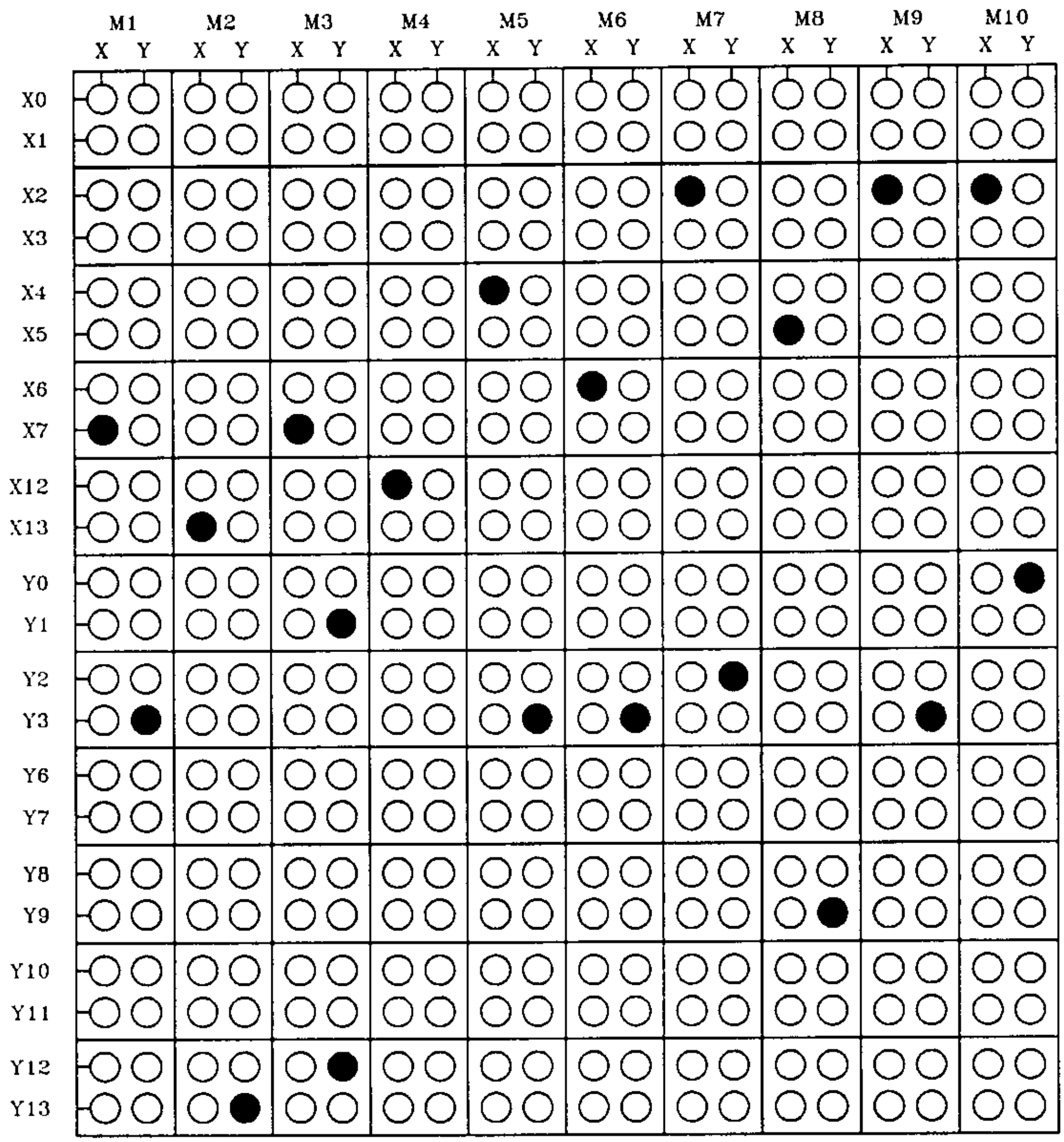
| X13 | X12 | X11 | X10 | X9 | X8 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | X0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHIFT | | | | | | | | | | | | | | Y13 |
| | RESET | | | | | | | | | | | | | Y12 |
| | | | | | | SHIFT | | | | | U | : | ; | Y11 |
| | | | | | | A | G | H | D | E | F | C | B | Y10 |
| | | | | | | X | Y | (-Y) PREV PAGE | 2 | | J | 5 | 8 | Y9 |
| | | | | | | W | < . | ? / | 3 | > . | M | 6 | 9 | Y8 |
| | | | | | | V | Z | T | 1 | = - | I | 4 | 7 | Y7 |
| | | | | | | L | R | S | O | P | Q | N | | Y6 |
| | | | | | | | | | | | | | | Y5 |
| | | | | | | | | | | | | | | Y4 |
| | | | | | | CYCLE START | (-X) ← | K | (+X) → | NEXT PAGE | (+Z) ↑ | O | ROLL DOWN | Y3 |
| | | | | | | CLEAR LINE | ENTER | | F6 | DEL CHAR | (+Y) ROLL UP | F4 | F2 | Y2 |
| | | | | | | FEED HOLD | | | F5 | INS CHAR | RECALL LINE | F3 | F1 | Y1 |
| | | | | | | | SPACE | | | | (-Z) ↓ | | | Y0 |

*Figure 10-5: Keyboard Matrix*

Referring to the above chart, if <CYCLE START> is designated as the first remote key, X7 and Y3 of the matrix must be jumpered to the appropriate opto isolator connections. The appropriate connections range from M1 to M10. The X/Y jumpers for M1 are for remote key #1, M2 for remote key #2, etc.

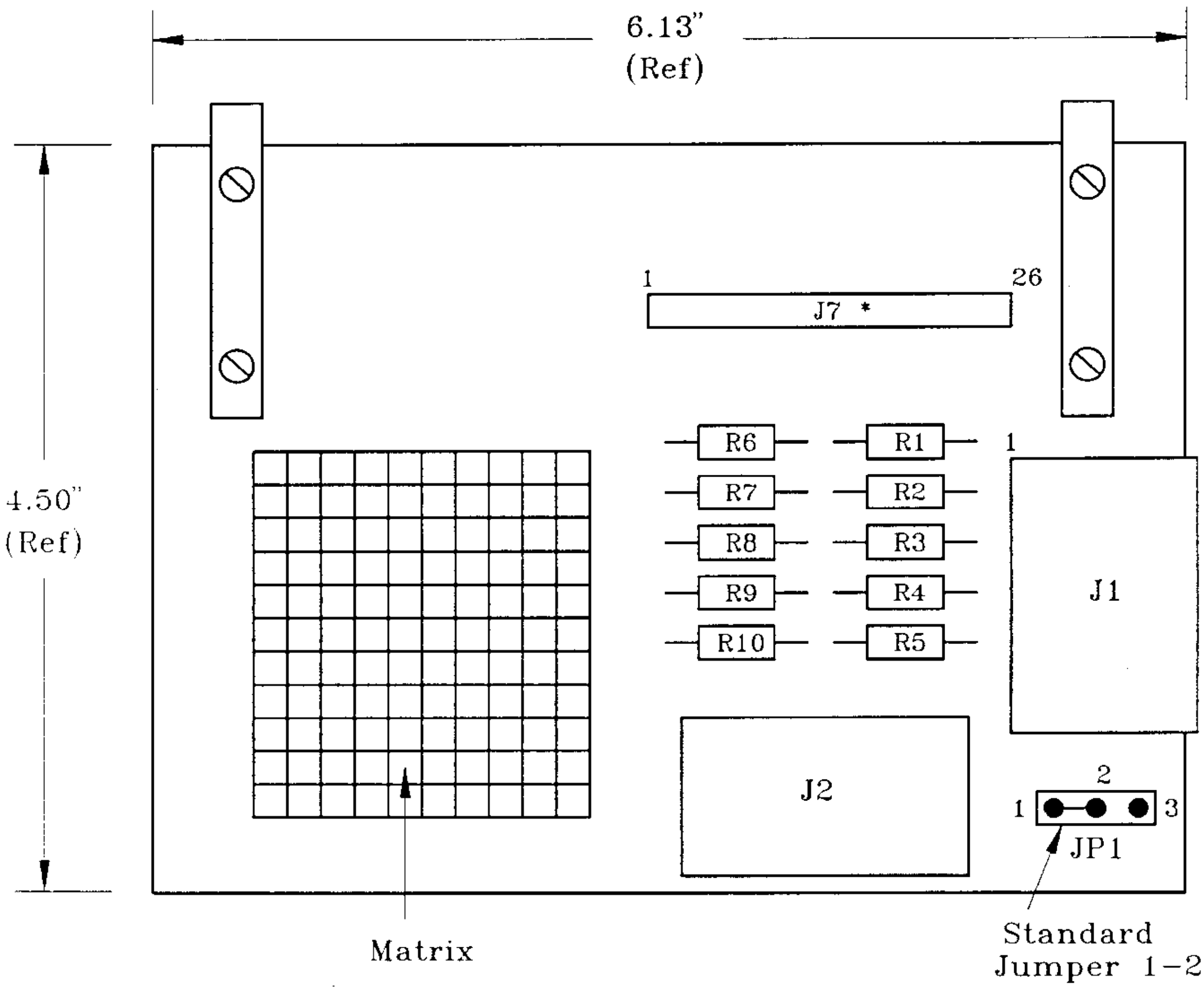
The following chart, figure 10-6, is an exact representation of the Opto Interface Board Matrix. (The layout of the entire board is presented in figure 10-7.) If, as in the prior example, <CYCLE START> is selected as the first remote key, then X7 and Y3 in the M1 column of the Opto Interface Board Matrix must be jumpered (M1: X7 in X column to be jumpered and Y3 in Y column to be jumpered.)

**NOTE:** Inserting jumpers into the matrix does not mean connecting one point to another. Connections are an integral part of the board, and each of the two points of an opto isolated input need only have a wire soldered into it. This connects the top of the board (X or Y trace) to the bottom of the board (M trace).




**NOTE:** SHOWN WITH STANDARD JUMPERS INSERTED

*Figure 10-6: Opto Interface Board Matrix*




NOTE: J7 A is on the top side of the board.
J7 B is on the bottom side of the board.

*Figure 10-7: Board Layout*

## 2. *OPTO INTERFACE BOARD CONNECTORS*

The interface to the Opto Interface Board is provided by connector FPJ1, located on the rear of the Unidex 16 enclosure. Cabling is provided to connect FPJ1 to the Opto Interface Board connector J2.

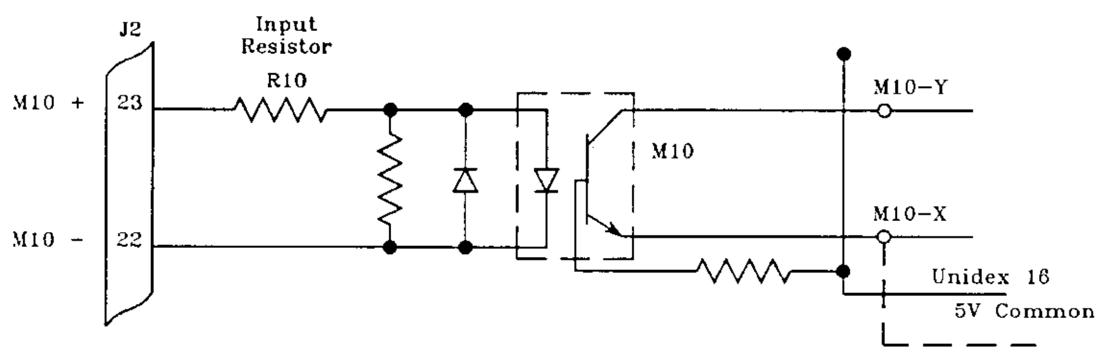
The following table lists the pin-outs of these two connectors, along with the opto isolated inputs M1 - M10.

| FPJ1 | J2 | INPUT |
|---|---|---|
| 3 | 5 | M1 + |
| 15 | 4 | M1- |
| 4 | 7 | M2+ |
| 16 | 6 | M2- |
| 5 | 9 | M3+ |
| 17 | 8 | M3- |
| 6 | 11 | M4+ |
| 18 | 10 | M4- |
| 7 | 13 | M5+ |
| 19 | 12 | M5- |
| 8 | 15 | M6+ |
| 20 | 14 | M6- |
| 9 | 17 | M7+ |
| 21 | 16 | M7- |
| 10 | 19 | M8+ |
| 22 | 18 | M8- |
| 11 | 21 | M9+ |
| 23 | 20 | M9- |
| 12 | 23 | M10+ |
| 24 | 22 | M10- |
| 13 | 25 | +V |
| 25 | 24 | +V |
| 2 | 3 | COM |
| 14 | 2 | COM |
| 1 | 1 | FRAME |

*Table 10-2: Pin-outs for FPJ1 and J2*

### *3. OPTO ISOLATED INPUTS*

The following (figure 10-8) demonstrates a typical opto isolated input (M1 - M10).




**Input Resistor Will Vary With Input Voltage**

**Input Resistors (R1 - R10):**
**Standard Value = 180 Ohm, 1/4 Watt**

**(Input Voltage - 1.4V/.02A) = Input Resistor**
**5V = 180 ohm 1/4 watt**
**14V = 680 ohm 1/2 watt**

*Figure 10-8: Typical Opto Isolated Input*

## 4. OUTPUT VOLTAGE JUMPER (+V)

For standard +5V operation, JP1 1-2 is jumpered. If +14V output voltage operation is desired, remove 1-2 and insert 2-3 and change the resistor values accordingly.

| JP1 | |
|---|---|
| 1-2 * | +5V |
| 2-3 | +14V (Unregulated) |

## 5. AEROTECH STANDARD REMOTE KEYS

The following (table 10-3) lists the ten remote keys that are the Aerotech standard.

| STANDARD KEY | INPUT | JUMPERS |
|---|---|---|
| CYCLE START | M1-Y | Y3 * |
| | M1-X | X7 * |
| SHIFT | M2-Y | Y13 * |
| | M2-X | X13 * |
| FEED HOLD | M3-Y | Y1 * |
| | M3-X | X7 * |
| RESET | M4-Y | Y12 * |
| | M4-X | X12 * |
| →(+X) | M5-Y | Y3 * |
| | M5-X | X4 * |
| ←(-X) | M6-Y | Y3 * |
| | M6-X | X6 * |
| ROLL UP (+Y) | M7-Y | Y2 * |
| | M7-X | X2 * |
| PREV PAGE (-Y) | M8-Y | Y9 * |
| | M8-X | X5 * |
| ↑(+Z) | M9-Y | Y3 * |
| | M9-X | X2 * |
| ↓(-Z) | M10-Y | Y0 * |
| | M10-X | X2 * |

*Table 10-3: Aerotech Standard Remote Keys*

**NOTE:** If the customer requires key selections other than those listed in table 10-3, Aerotech will make the necessary changes.

If changes are to be made once the Opto Interface Board leaves the factory, the customer must remember to remove the jumpers associated with the previous key before inserting the new jumpers.

## SECTION 10-6 LASER FIRING CARD OPTION

The Laser Firing Card enables a laser to be fired with precision by calculating the vectorial positions of any 1 or 2 axes (X, Y, Z, U, V or W) at any given time. It also outputs the vectorial data rate as an analog signal.

The laser firing option is a function of the I/O bus and is enabled through the parts program or the MDI mode. For programming laser firing control, see chapter 13 of the *Unidex 16 Motion Controller Programming Manual.*

### A. LASER FIRING CARD SPECIFICATIONS

**Overall Dimensions:**

| | |
|---|---|
| Length | 14.50" |
| Width | 9.25" |

**(Versabus size: fits into Unidex 16 card cage)**

**Output:**

Opto-Isolated Signal:

| | |
|---|---|
| Maximum voltage | 30 volts |
| Maximum current | 25 mA |
| Recommended load | 2K ohms |

| | |
|---|---|
| TTL Signal: | |
| Maximum voltage | 5 volts |
| Open-collector | 4.7K ohm pull-up |
| Pulse Width: | |
| Opto-isolated signal | 60 μS to 65595 μS |
| TTL signal | 1 μS to 65535 μS |
| Data rate analog signal: | |
| Minimum voltage | 0 VDC |
| Maximum voltage | 9.9 VDC |

**NOTE:** With either Opto-isolated or TTL signal, the output pulse may be positive enabled or negative enabled. The choice is made by selecting the appropriate jumper (TTL) or changing two resistor values (opto-isolated).

## B. INSTALLATION INSTRUCTIONS

The customer connections required are the output connections at J3.

The 50 pin Champ connector, J5, connects to the CRT board I/O Channel (A3-J4).

### *1. OPTO-ISOLATED OUTPUT SIGNAL*

The Laser Firing Card can be interfaced to a laser via an opto-isolated signal. The opto-isolated signal is provided by J3, a 10-pin Weidmuller connector.

A description of the opto-isolated signal and associated hardware is as follows:

| | |
|---|---|
| PIN 1 | + V input ( +5V to +30V) |
| PIN 2 | Opto + |
| PIN 3 | Opto - |
| PIN 4 | Common |

| | |
|---|---|
| R1 = | 2.2K ohms, 2 watt (R2 = 0 ohms) for negative output pulse |
| R2 = | 2.2K ohms, 2 watt (R1 = 0 ohms) for positive output pulse |

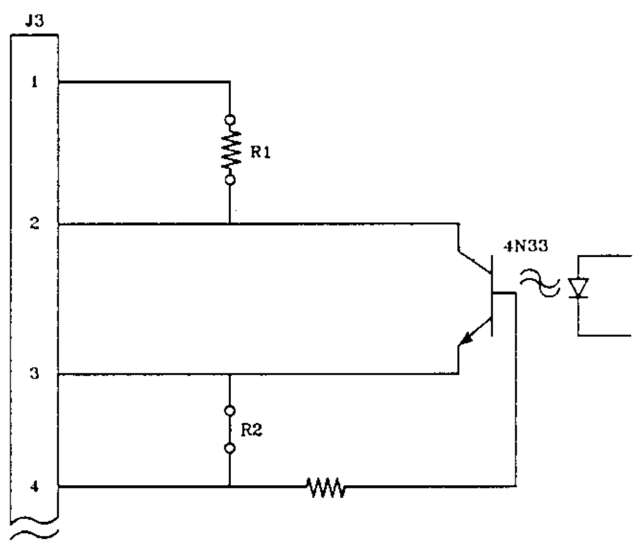



*Figure 10-9: Opto-Isolated Signal Pin-out*

## 2. TTL OUTPUT SIGNAL

The Laser Firing Card also provides a TTL signal. The TTL signal is provided by the same Weidmuller connector as mentioned previously. The associated jumper JP1 determines whether the output pulse will be positive or negative.

A description of the TTL signal is as follows:

| | |
|---|---|
| PIN 8 | Laser firing pulse TTL open-collector output with on-board 4.7K ohm pull-up resistor. |
| PIN 7 | Ground |
| JP1 | TTL laser firing pulse waveform control: |

**1-2 is negative output pulse**
**2-3 is positive output pulse**

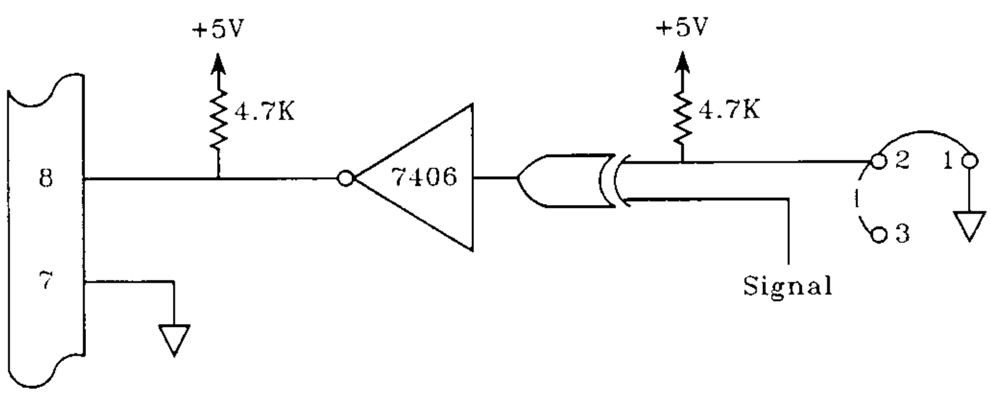



*Figure 10-10: TTL Output Pulse Pin-out*

*3. PULSE WIDTH*

The pulse width is programmable through the I/O channel via commands \$6FA = H,nn and \$6FB = H,nn.

See the *Unidex 16 Motion Controller Programming Manual* .

*4. DATA RATE ANALOG SIGNAL*

The data rate analog signal depends on the data rate from the encoder feedback. A 0 volt (slowest speed) to 9.9 volt (highest speed) analog signal will be output through the same Weidmuller connector. The pin assignments are:

**Pin 10 = Analog Voltage**
**Pin 9 = Common**

The data rate scaling can be programmed through the I/O bus. See the *Unidex 16 Motion Controller Programming Manual.*

## SECTION 10-7 PROGRAMMABLE S-FUNCTION D/A

The purpose of the Programmable S-Function D/A Converter Card is to enable a digital S-function output from Unidex 16 to be converted to an analog signal. The analog signal is used to control either a unipolar or bipolar spindle, or other type of device requiring an analog output signal.

The "S" function D/A board can either be plugged into the MST bus of the I/O card cage, or it can be mounted on the rear of the Unidex

16 card cage. It is interfaced to the MST bus through a 64 pin DIN connector, J1, and provides customer connections at J2.

The S-Function D/A Card provides the following features:

- Precision 12 bit DAC
- CMOS/TTL compatible
- Data/Data-N inputs
- Strobe/Strobe-N control input
- Reset/Reset-N control input
- Acknowledge-N output
- One-half second power-on Reset
- Bipolar binary input (±10V, ±5V, ±2.5V)
- Unipolar binary input (0 - +10V, 0 - +5V)
- Unipolar BCD (0 - +10V)
- 3U or 6U Eurocard form
- Convenient screw-terminal user interface

## A. S-FUNCTION D/A BOARD SPECIFICATIONS

| | |
|---|---|
| Board Size | 3U or 6U (See figure 10-11 for overall dimensions) |

### Suggested Mating Connectors:

| | |
|---|---|
| J1 (MST Bus) | 3M 3338-0001 (ECK355) |
| P2 (User Interface) | Weidmuller 5131.6 (EIK 512) |

**NOTE:** P2 is supplied with S-Function D/A Card

### Power Requirements:

| | |
|---|---|
| +12V | +11.4 to +16V at 40mA |
| + 5V | + 4.75 to 5.25V at 120mA |
| -12V | -11.4 to -16V at 40mA |

### Inputs:

| | |
|---|---|
| Data Inputs D0 - D11 | LS TTL with 10K pull-up (74LS244/74LS240) |

### Control Inputs:

| | |
|---|---|
| Strobe-N, Reset-N | CMOS Input with 10K Pull-up |
| Debounce Active | Min. Pulse input 250μS |
| Debounce Bypass | Min. Pulse input 2μS |

### Acknowledge Output :

Open Collector TTL 7406

### Analog Output:

| | |
|---|---|
| Max. Voltage | ±10V |
| Max. Current | ±5mA (2Kohm load) |
| Overall Accuracy | ±1 LSB Typical |
| Worst Case Accuracy | ±.1 % of full scale |
| Monotonicity Temp. Range | 0 to 50 C |

Accuracy Spec is based on
±10V Binary
Output at 10 to 50 C

## B. OPERATION

### 1. DATA AND CONTROL INPUTS

The programmable S-Function D/A Card is pin for pin compatible with the Unidex 16 MST bus. Data and control inputs are accomplished via the 64 pin DIN connector, P1. The S-function D/A board is standardly supplied to accept Data-N, Strobe-N and Reset-N (active low) inputs. However, input devices and jumpers can be changed to accept data, strobe and reset. All inputs are pulled up with a 10K resistor.

| | **M2 and M3** |
|---|---|
| * Data | 74LS244 |
| Data-N | 74LS240 |

| | JP2 |
|---|---|
| Strobe | 1-2 |
| * Strobe-N | 2-3 |

| | JP1 |
|---|---|
| Reset | 1-2 |
| * Reset-N | 2-3 |

**NOTE:** A .5 second Power-on Reset is provided internally by M9 (MC 1455 Timing Circuit).

### 2. MSB/SIGN INPUT

This jumper is for use with Unidex 16 and will always be in position 1-2. This jumper was provided for special applications where the sign bit may only be available on signal D15 (P1-A13).

**MSB/Sign Jumper JP3**

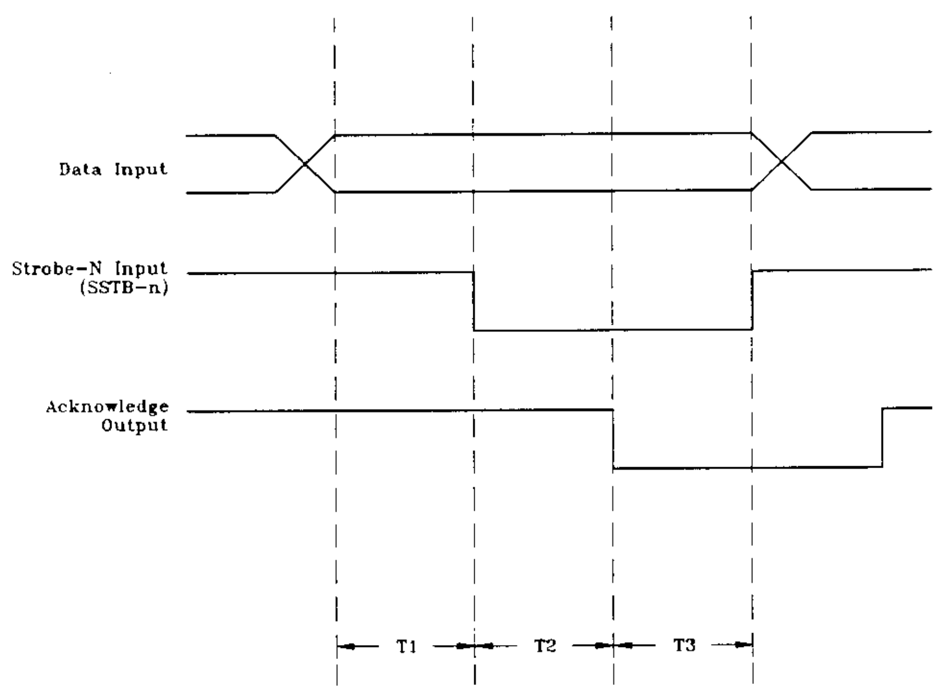
| | |
|---|---|
| * D11 | 1-2 |
| D12 | 2-3 |

### 3. *ACKNOWLEDGE OUTPUT*

The ACK-N out signal is an active low, open-collector, handshaking signal which is used by Unidex 16 for synchronous communication.

### 4. *TIMING*

The timing diagram below illustrates the timing cycle utilized by Unidex 16 when sending data to the S-function D/A Card.



| | |
|---|---|
| T1 Data to SSTB-N Low | 1 mS typical, determined by Unidex 16 parameter #402 (0 0 0 0 1) |
| T2 SSTB-N Low to ACK-N Low | 250 uS typical, determined by "S" D/A board debounce circuit M1 and C17 |
| T3 ACK-N Low to Strobe-N Hi | 1 mS typical, determined by Unidex 16 parameter #410 (0 0 0 0 1) |

**NOTE:** Standard Unidex 16 default value for parameters 402 and 410 is 00010 for 10mS. Although 10mS for T1 and T2 will operate properly with the "S" D/A board, it is not optimum timing.

## *5. DAC CONFIGURATION*

The programmable S-function D/A Card is normally supplied in the ±10 Binary configuration. This, as well as the other configurations listed, are achieved by changing the following board jumpers and components. These changes ensure compatibility with the various digital input coding.

JP4 (16 PIN DIP HEADER)

| Configuration | 1-16 | 2-15 | 3-14 | 4-13 | 5-12 | 6-11 | 7-10 | 8-9 | M10 DAC |
|---|---|---|---|---|---|---|---|---|---|
| • +/-10V Binary | OUT | IN | OUT | IN | OUT | IN | OUT | OUT | DAC80Z CBIV |
| +/-5V Binary | OUT | IN | OUT | OUT | IN | IN | OUT | OUT | " |
| +/-2.5V Binary | OUT | IN | IN | OUT | IN | IN | OUT | OUT | " |
| 0 to 10V Binary | IN | OUT | OUT | OUT | IN | OUT | IN | OUT | " |
| 0 to 5V Binary | IN | OUT | IN | OUT | IN | OUT | IN | OUT | " |
| 0 to 10V Binary | OUT | OUT | OUT | IN | OUT | OUT | IN | OUT | DAC80Z CCDV |

## C. ADJUSTMENTS

The following list of adjustments are completed at Aerotech. However, if the DAC is replaced in the field, the user is responsible for these adjustments.

### 1. *UNIPOLAR*

- For S0, adjust Balance Pot, R1, for 0.000V, ±.002V.
- For S Max, adjust for full scale output voltage, ±.002V.

### 2. *BIPOLAR*

- For S -Max, adjust R1 for -full scale output voltage, ±.002V.
- For S +Max, adjust R2 for +full scale output voltage, ±.002V.
- For S0, adjust R1 for 0.000V, ±.002V.

## D. INTERFACE

This section lists the pinouts for both J2 and P1.

**J2**

| Pin # | Signal Name |
|---|---|
| 1 | Analog Output |
| 2 | Analog GND |
| 3 | +12V |
| 4 | + 5V |
| 5 | Common |
| 6 | -12V |

## P1

| PIN # | SIGNAL NAME | PIN # | SIGNAL NAME |
|---|---|---|---|
| C1 | CIRQ-N (Reserved) | A1 | COMMON |
| C2 | FAULT (Reserved) | A2 | COMMON |
| C3 | HALT-N (Reserved) | A3 | COMMON |
| C4 | SPARE | A4 | COMMON |
| C5 | MSTRST-N | A5 | COMMON |
| C6 | ACK-N | A6 | COMMON |
| C7 | ACCL (Reserved) | A7 | COMMON |
| C8 | SPARE | A8 | COMMON |
| C9 | SSTB-N | A9 | COMMON |
| C10 | TSTB-N (Reserved) | A10 | COMMON |
| C11 | COMMON | A11 | SPARE |
| C12 | SPARE | A12 | RESERVED |
| C13 | SPARE | A13 | D15 |
| C14 | D13 (Reserved) | A14 | D14 (Reserved) |
| C15 | D11 | A15 | D12 (Reserved) |
| C16 | D09 | A16 | D10 |
| C17 | D08 | A17 | COMMON |
| C18 | MSTB-N (Reserved) | A18 | COMMON |
| C19 | RESERVED | A19 | COMMON |
| C20 | COMMON | A20 | D07 |
| C21 | D05 | A21 | D06 |
| C22 | D03 | A22 | D04 |
| C23 | D01 | A23 | D02 |
| C24 | D00 | A24 | COMMON |
| C25 | COMMON | A25 | COMMON |
| C26 | -12V | A26 | -12V |
| C27 | RESERVED | A27 | RESERVED |
| C28 | +12V | A28 | +12V |
| C29 | +5V | A29 | + 5V |
| C30 | +5V | A30 | +5V |
| C31 | COMMON | A31 | COMMON |
| C32 | COMMON | A32 | COMMON |

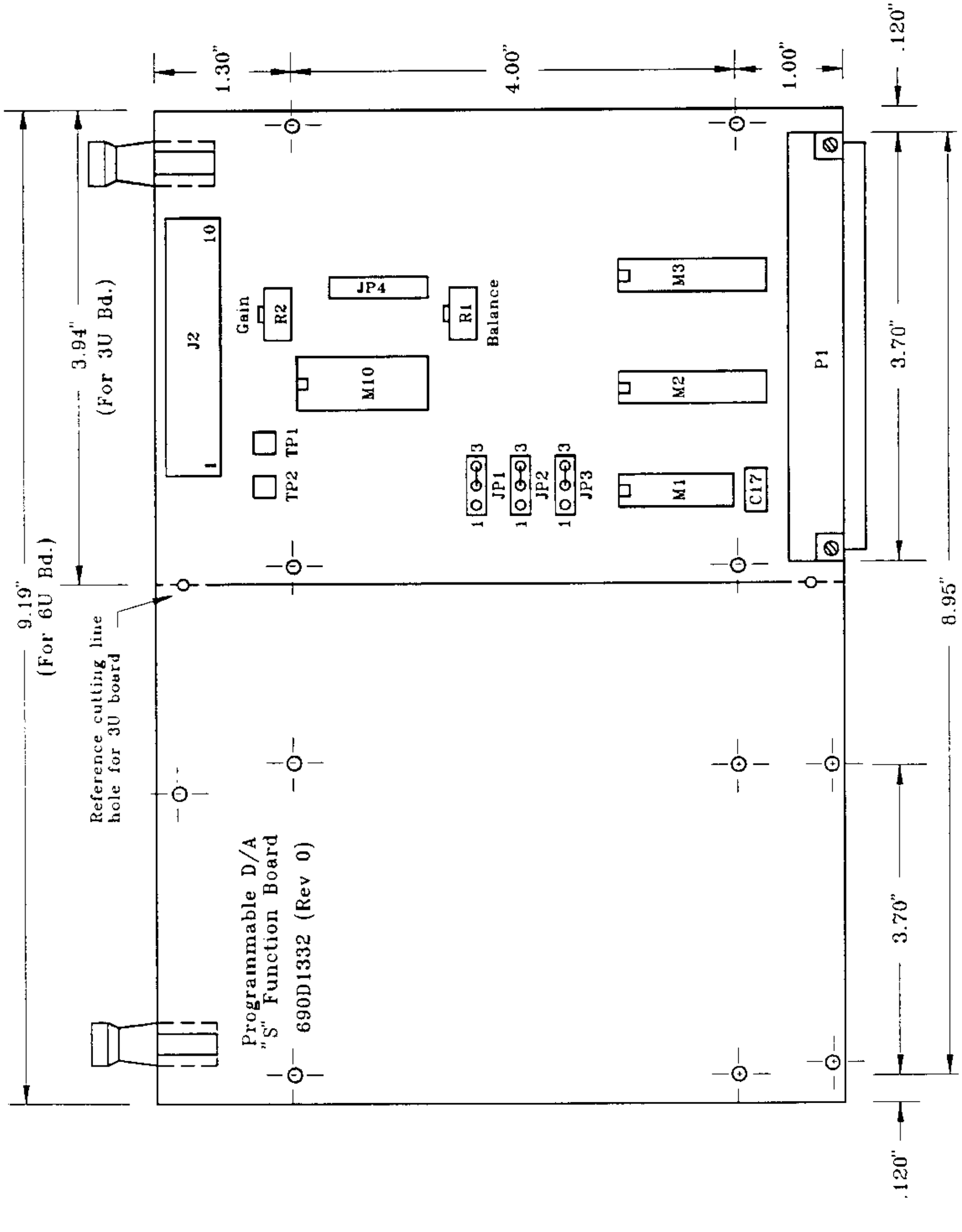



*Figure 10-11: Programmable D/A S-Function Board*

## SECTION 10-8 MEMORY BOARD OPTION

Aerotech standards for jumper selections will be indicatd with an asterisk (*).

Up to two memory boards may be added to your basic Unidex 16 system. The memory board fits into the card cage, slot A5 (and A6 if a second memory board is added).

The memory board can contain 128K or 256K bytes of memory. The standard board will be supplied with 128K of memory.

The end address of user's memory, or RAM, is set in parameter 100. It is set at 65535 for the 16K of memory that comes with the basic Unidex 16 system. For each additional 128K of memory added to the system's RAM, add the number 131,072 to the number residing in parameter 100.

### A. MEMORY BOARD SWITCHES

Depending on the amount of memory purchased, the following RAM chips and switch settings will be required.

**NOTE:** Of course, as you add another increment of memory, the previous RAM chips remain and the previous switch settings stay on. With each new memory bank added, the new chips and switch settings are added to the previous ones.

(All switches must be off, except those indicated as "on" for the appropriate amount of memory in your system.)

| | RAM | RAM CHIPS | SWITCH TO ON POSITION A5 (1st Card) | SWITCH TO ON POSITION A9 (2nd Card) |
|---|---|---|---|---|
| 1. | 32K | M1, 2, 15, & 16 | SW4-1 & 9 | SW4-1, 3 & 9 |
| | 64K | M3, 4, 17 & 18 | | |
| | 96K | M5, 6, 19 & 20 | | |
| | * 128K | M7, 8, 21 & 22 | SW3-2 & 9 | SW3-2, 3 & 9 |
| 2. | 160K | M34, 35, 48 & 49 | SW2-1, 2 & 9 | SW2-1, 2, 3 & 9 |
| | 192K | M36, 37, 50 & 51 | | |
| | 224K | M38, 39, 52 & 53 | SW1-3 & 9 | SW1-4 & 9 |
| | 256K | M40, 41, 54 & 55 | | |

## B. BATTERY JUMPERS

Change both batteries, one at a time, when the "Battery Low" message appears on the screen at power-up.

| JMP1 | |
|---|---|
| IN | * Battery #1 active |
| OUT | Battery #1 inactive |

| JMP 2 | |
|---|---|
| IN | Battery #2 active |
| OUT | * Battery #2 inactive |

| JMP 3 | |
|---|---|
| IN | External battery active |
| OUT | * Internal battery active |

1. *Replacing Battery #1*

Remove jumper #1. Remove battery #1. Insert and solder battery #1 and insert jumper #1.

2. *Replacing Battery #2*

Remove jumper #2. Remove battery #2. Insert and solder battery #2 and insert jumper #2.

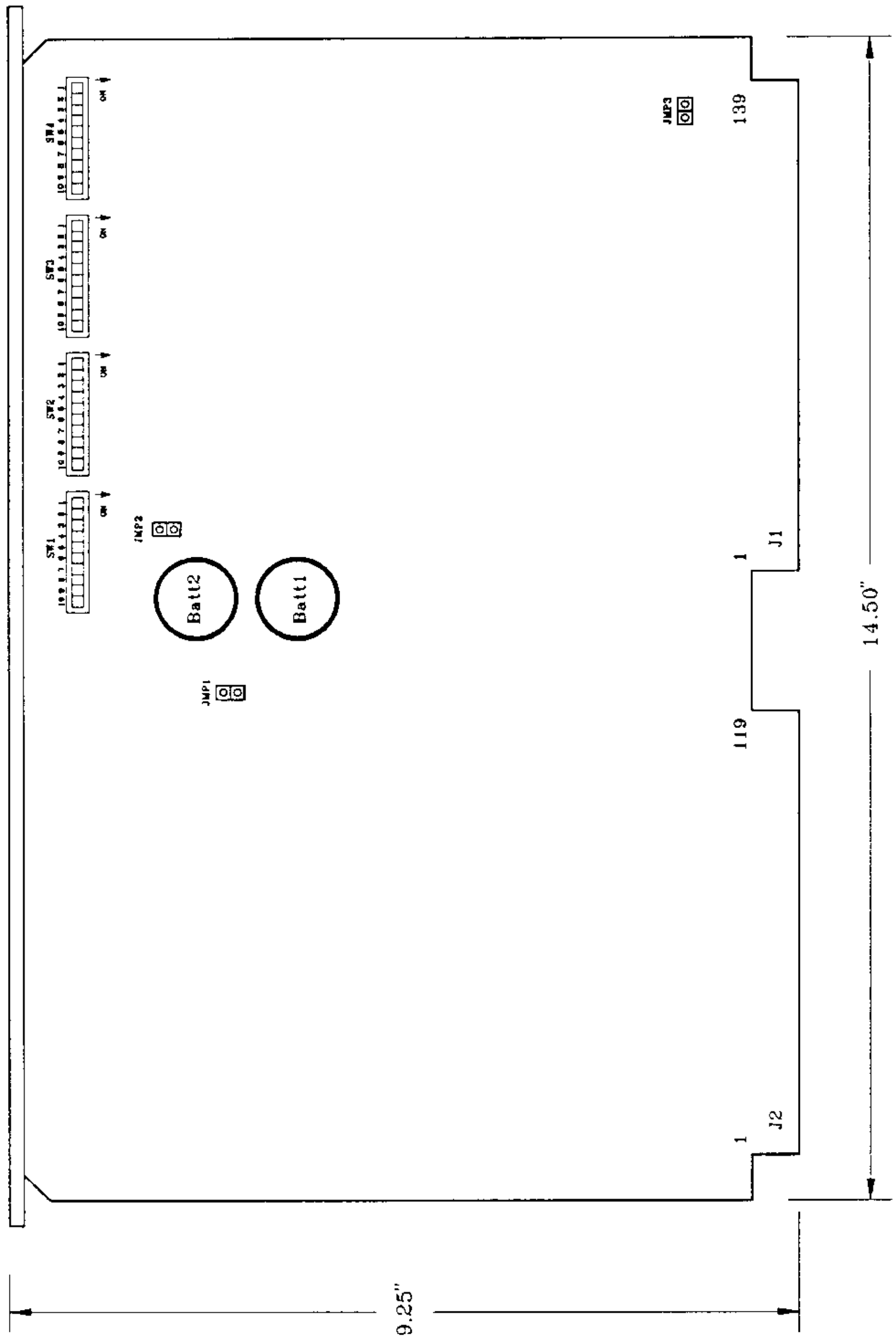



*Figure 10-12: Memory Board*

## SECTION 10-9 AXIS CALIBRATION OPTION (AX-CAL)

Calibration of an axis is necessary when the distance traveled by an axis differs from the programmed distance.

One way to measure the tolerance of an axis is to jog the axis a certain number of steps. Then measure the physical distance traveled. Any discrepancy between that distance and what has been programmed is your calibration.

To use axis calibration, power down Unidex 16 and plug the special programming key into J5 on the CPU board. Power-up the system and go into the EEPROM parameter mode (see the following table).

**Axis under Calibration : X**

**Distance (machine step) : 00000000**

| | | | | | |
|---|---|---|---|---|---|
| 001 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 006 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 011 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 016 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 021 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 026 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 031 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 036 : | +00000 | +00000 | +00000 | +00000 | +00000 |
| 041 : | +00000 | +00000 | +00000 | +00000 | +00000 |

STATUS : read & revise .EEPROM

store select skip-up skip-dn end

*Table 10-4: Axis Calibration Screen*

<Next Page> will access lines 046 to 111. Press <Next Page> again to access lines 116 to 181.

The first line, "Axis under Calibration" lists the axis to be calibrated.

The second line, "Distance", lists the distance in *machine steps* that the axis must travel before one full calibration step is added. This entry must always be a *positive number.* (Enter 0 to override axis calibration.)

The last type of information is the calibration data. Each listing (totaling 338) is an entry for one increment of distance, starting from the machine home position. This data may range from -32767 to +32767. If nothing is entered, the default value is 0.

The [select] soft key changes the axis under calibration. Just press the [select] key to go to the next axis.

After all calibration data is entered, press [end]. Then power down the system and remove the key from J5 on the CPU board. When the key is removed, the axis calibration screen cannot be seen.

## Running the System with Axis Calibration

When running the system with axis calibration, remember the following:

1. Any axis to be run under calibration *must first be sent to machine home.* If not, the axis will move without calibration.

2. If "Distance" is listed as zero, the axis will run without calibration. This is helpful when calibration is to be eliminated temporarily. Instead of changing all of the calibration data to zero, just enter the distance as zero.

3. If the distance to be traveled by an axis ends in the middle of a "distance" increment, the calibration count will be determined by the following equation:

   **Full Counts * (Distance Traveled/ Distance Increment)**

4. When running the system with axis calibration, the tracking display will not show the calibration count with either the machine step or program step tracking.

5. Unidex 16 is capable of doing multiquadrant circular contouring. However, if axis calibration is used on either or both axes involved in a circular move, only single quadrant programming is allowed.

## SECTION 10-10 KEYBOARD INTERFACE

The external keyboard option allows the user to enter programs via a conventional full-travel Qwerty-keyboard. The connection for the keyboard is made through the front panel.

The keyboard may output either synchronous key scan code (IBM compatible) or RS-232 ASCII code. Either keyboard selection requires a different group of jumper selections as well as a different parameter setting for parameter #120.

### RS-232 ASCII Keyboard Interface

Rate fixed at 1200 baud, 8 bits/character, 1 stop bit. Set EEPROM parameter #120, bit 1 to 1 for ASCII decoding. Set bit 2 to 0 for no parity and bit 2 to 1 for even parity.

Jumper the following:

**CRT Board JP8 2-3**
**Front Panel Board 16-17**

For more information, as well as the placement of jumpers, see sections pertaining to CRT and Front Panel Boards in chapter 7.

## IBM PC Keyboard Interface

Rate fixed at 19200 baud, 8 bits/character, 1 stop bit. Set EEPROM parameter #120, bit 1 to 0 for IBM decoding. Bit 2 is not used. Fixed at no parity.

Jumper the following:

**CRT Board JP8 2-3**
**Front Panel Board 15-16 and 17-18**

For more information, as well as the placement of jumpers, see sections pertaining to the CRT and Front Panel Boards in chapter 7.

For more information on the keyboard interface, see the *Unidex 16 Motion Controller Programming Manual*, chapter 13.

## SECTION 10-11 BRAKE CONTROL BOARD

The Unidex 16 Brake Board is designed to keep a vertical axis from dropping when power is turned off, when a system fault occurs, or when a motor fuse is blown. Although the standard Brake Control option is meant to operate with a 24VDC normally engaged brake that is released when power is applied, the form "C" output relay can be used to accommodate other configurations.

The Brake Control option offers the following features:

- 6U or 3U size
- On-board 24VDC power supply
- 2-Axis operation
- Blown output fuse detection
- Brake interlock inputs
- Convenient screw terminals for user interface
- Shutdown/Shutdown-N inputs
- Reset/Reset-N input
- Fault output
- Form "C" relay output
- Power-on reset
- Brake fly-back diode
- Trap and latch-on system fault

### A. OPERATION

In the standard configuration, whenever the power is turned off, the brake will be engaged. Also, whenever the motor fuse is detected to be open or a brake interlock is active, the Brake Control will assert its fault output signal, energize the brake, and light the Brake Control's fault (DS2) and brake indicator light (DS1).

The shutdown input can also activate the brake, but will only light the brake indicator light (DS1) when in the standard configuration. However, when the board is configured to trap and latch on system faults by means of the shutdown input, any system fault will cause the Brake Control to activate the brake and to remain activated until cleared by a reset. When used in this configuration, both fault and brake indicator lights will light.

## B. SPECIFICATIONS

| Characteristics | Specifications |
|---|---|
| **Overall Dimensions** | |
| | 6U 3U |
| Length | 9.19" 3.94" |
| Width | 6.30" 6.30" |
| Thickness | 1.56" 1.56" |
| **Suggested Mating Connectors** | |
| J1 64 Pin DIN Connector (brake interface) | 3M 3332-0001 |
| TB1 14 Pin Terminal (aux. brake terminal) | Weidmuller 1275.6 |
| J2 2 Pin Terminal (input power) | Weidmuller 5104.6 |
| **Input Power Requirements** | |
| Standard Input Power | 115 VAC .25A 50/60 Hz |
| Optional Input Power | 230 VAC .13A 50/60 Hz |
| Input Fuse (2 amp) | Pico Fuse<br>Littlefuse Part #275002 |

| Characteristics | Specifications |
|---|---|
| **Inputs** | |
| Motor Fuse Input | 40 to 60V bus, 25V trip<br>* R1 - R4 = 3.3K 2W (standard)<br>80 to 160V bus, 60V trip<br>R1 - R4 = 10K 1W |
| Axis 1/Axis 2 Interlock | LSTTL filtered input, 10K pull-up, active high |
| System Reset-N | LSTTL, 10K pull-up, active low |
| Controller +5 | CMOS with a 10K pull-up, active high |
| Reset | CMOS input, 10K pull-up, active high |
| Shutdown | CMOS input, 10K pull-up, active high |
| Shutdown-N | CMOS input, 10K pull-up, active high |
| **Outputs** | |
| Fault | 74LS05 output device |
| Brake Output Relay | Single pole relay normally open and normally closed contacts.<br>Contact Rating:<br>5A @ 125 VAC/24 VDC<br>(resistive load) |
| 24V Output | 24VDC .5 amps<br>Fuse 2A Pico fuse<br>Littlefuse part #275002 |

## Jumpers

*JP1*

| | |
|---|---|
| IN | Axis 1 interlock disabled |
| OUT | * Axis 1 interlock enabled (standard) |

*JP2*

| | |
|---|---|
| IN | * Axis 2 interlock disabled (standard) |
| OUT | Axis 2 interlock enabled |

*Reset Input*

JP5

| | |
|---|---|
| IN | * Reset input disabled (standard) |
| OUT | Reset input enabled |

*Shutdown Input*

JP6

| | |
|---|---|
| IN | Shutdown input disabled |
| OUT | * Shutdown input enabled (standard) |

*Power On Reset Jumper*

JP4

| | |
|---|---|
| 1-2 | * Power on reset active (standard) |
| 2-3 | Power on reset disabled |

*Controller +5V Jumper*

JP9

| | |
|---|---|
| IN | Disabled |
| OUT | * Controller +5V input active (standard) |

*Brake Fault Latch Jumper*

| JP3 | JP7 | |
|---|---|---|
| 1-2 | IN | * Latch function disabled (standard) |
| 2-3 | OUT | Latch function active - will latch on any system fault. Must be reset to clear. |

*Input Power Jumper*

| | |
|---|---|
| JP8, 1-2, 3-4 | * 115V input power (standard) |
| JP8, 2-3 (only) | 230V input power |

## C. INTERFACE

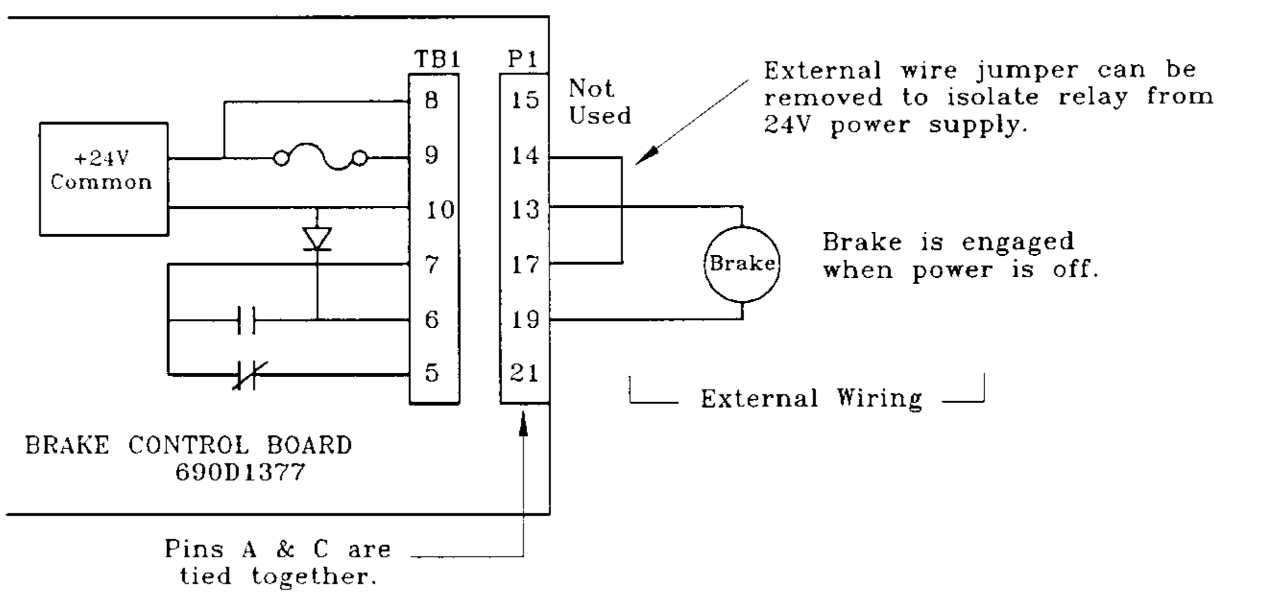
**Connector P2**

| | |
|---|---|
| Pin 1 | AC Line |
| Pin 2 | Neutral |

**Connector P1 and TB1**

| TB1 | P1 | | TB1 | P1 | |
|---|---|---|---|---|---|
| | 1A, 1C | Controller +5V input | 7 | 17A,17C | Relay wiper |
| | 2A, 2C | Fault output | | 18A,18C | 24V common |
| | 3A, 3C | Shutdown-N input | 6 | 19A,19C | Relay N.O. |
| | 4A, 4C | Shutdown input | | 20A,20C | Spare |
| | 5A, 5C | Reset input | 5 | 21A,21C | Relay N.C. |
| | 6A, 6C | Reset-N input | | 22A,22C | Spare |
| | 7A, 7C | Signal common | | 23A,23C | Spare |
| 14 | 8A, 8C | Axis 1 interlock input | | 24A,24C | Spare |
| 13 | 9A, 9C | Signal common | 4 | 25A,25C | Axis 2 motor fuse input |
| 12 | 10A,10C | Axis 2 interlock input | | 26A,26C | Spare |
| 11 | 11A,11C | Signal common | 3 | 27A,27C | Axis 2 motor fuse input |
| | 12A,12C | Signal common | | 28A,28C | 24V common |
| 10 | 13A,13C | 24V common | 2 | 29A,29C | Axis 1 motor fuse input |
| 9 | 14A,14C | Brake 24V | | 30A,30C | 24V common |
| 8 | 15A,15C | Unfused 24V | 1 | 31A,31C | Axis 1 motor fuse input |
| | 16A,16C | 24V common | | 32A,32C | Spare |

TYPICAL OUTPUT WIRING



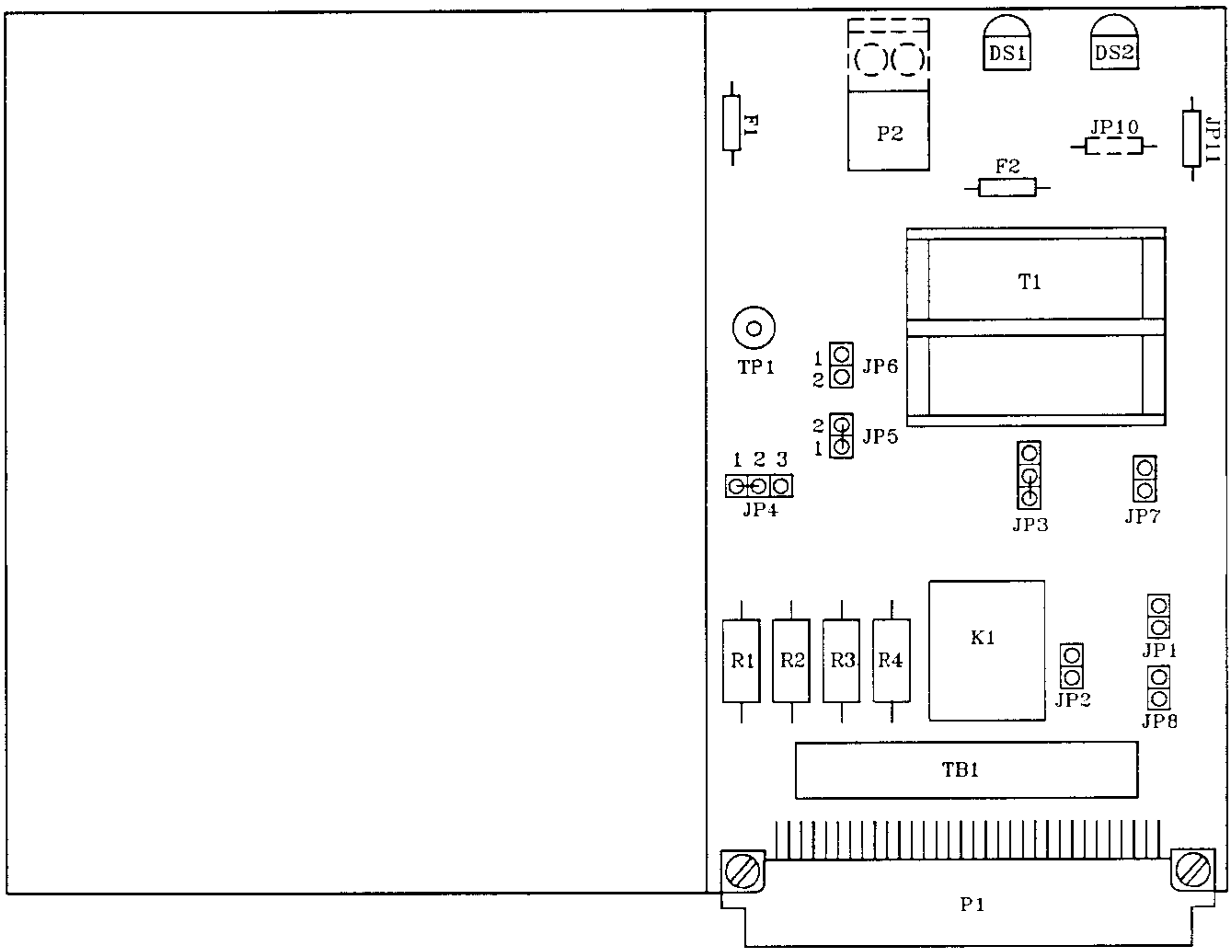



*Figure 10-13: Brake Control Board*

# CHAPTER 11: FAULT/SHUTDOWN CIRCUIT

The Unidex 16 incorporates a fail-safe fault and shutdown circuit that is meant to halt system execution and, in some cases, to avert a possible runaway condition when a detectable malfunction is reported. The design is fail-safe in that, if the fault signal is absent due to the removal of a critical assembly or cable, a fault and a subsequent shutdown will occur.

The fault signal is daisy chained through the Unidex 16 card cage mother board, from one module to the next. Each module or assembly that uses the fault signal is equipped with an active high TTL fault input (J2-64) which is pulled up with a 1K resistor and a high voltage open collector TTL output (J2-63). Bypass switches are provided on the Unidex 16 mother board to bypass modules that do not use the fault circuit. (See section 7- 1, *Card Cage Jumpers and Switches.*)

The output of the last module in the fault circuit will be connected to the input of the shutdown circuit (A9J9-7 to A9J9- 6). The shutdown signal is active high and can be either a 5 volt and/or 12 volt logic signal. Each module on the shutdown circuit is equipped with its own input diode and pull-up resistor, so 5V and 12V inputs can exist on the bus together.

When a fault is detected, the module reporting the fault will assert its fault output and light a fault indicator light located on the module. The fault signal will ripple through each subsequent module in the fault circuit and the last module will activate the shutdown input. The Unidex 16 will read the shutdown signal on the CRT board and display the error message "drive fault".

Depending on the setting of parameter #151, the Unidex 16 will:

**Ignore the signal**
**Display error message "drive fault" and continue execution of program**
**Display error message and stop execution of program**

The shutdown signal will also shutdown the output stage of the Unidex 16 servo controller.

For the customer interface, there are two fault inputs. There is one at A9J9-8 and another through the MST bus at A3J4-49. Both of these inputs must be pulled low when not in use. A9J9-8 is jumpered to A9J9-1, and jumper JP6 1-2 on the CRT board will disable the MST bus fault input. (See section 7-3 on the CRT board for more information.)

The fault output signal is available at A9J9-7 and the shutdown input is available at A9J9-6. For more information on the fault and shut down circuit, see figure 11-1.

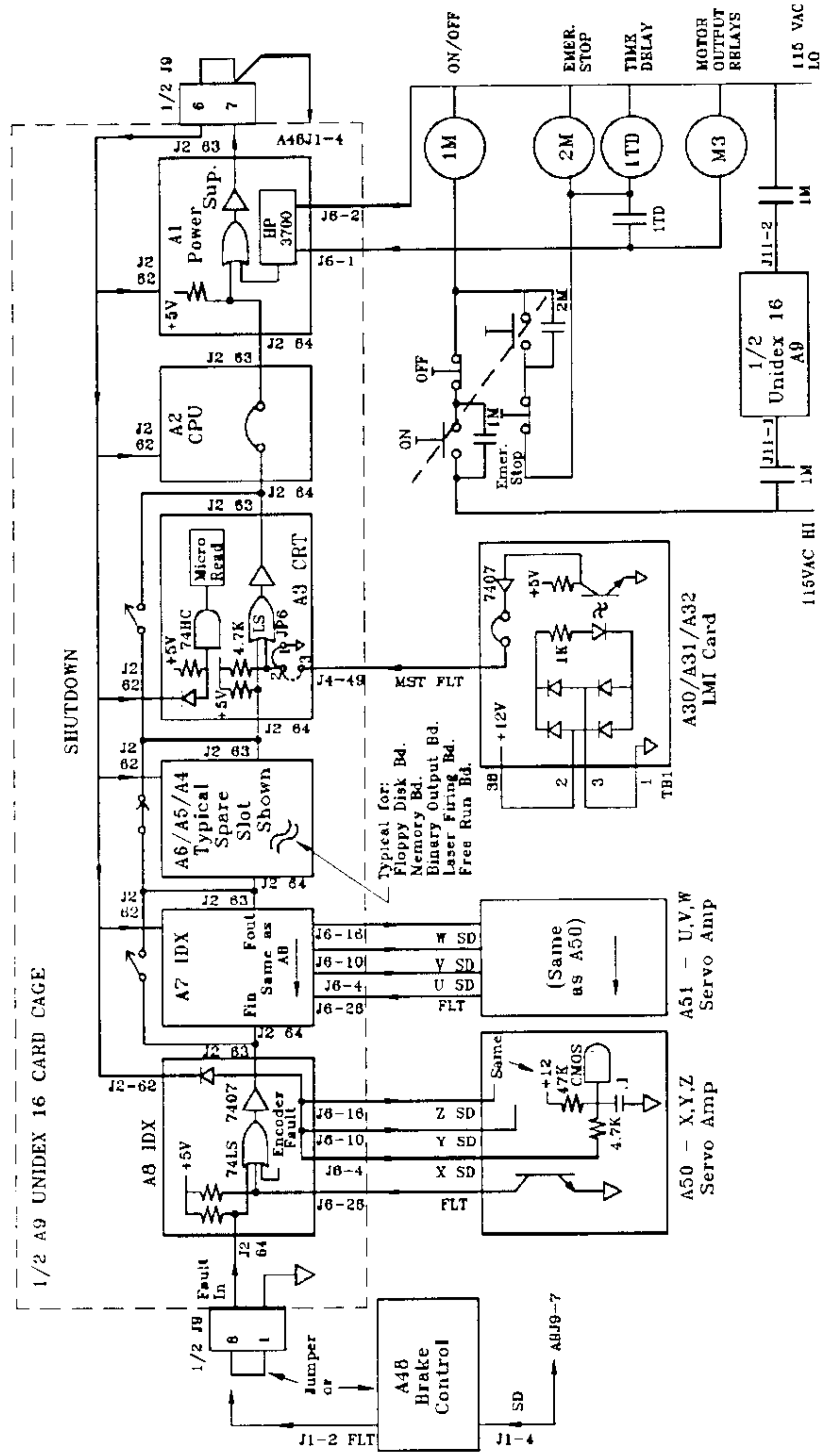



*Figure 11-1: Unidex 16 Fault and Shutdown Circuit*

The following, table 11-1, lists the Unidex 16 assemblies that can activate the fault/shutdown circuit and the possible causes of the problems.

| Assembly | Problem |
|---|---|
| A1, Power Supply | Emergency stop circuit has been activated. This is a latched condition that must be cleared by pulling out the emergency stop switch and pressing the power on switch. |
| A3, CRT Board | MST bus fault input active. This is a user input (usually through the Unidex 16 LMI card).<br><br>**CAUTION**: *This is not a latched condition.* |
| A7/A8 Indexing Board | Encoder fault circuit active. This is a latched condition that must be cleared by resetting the system. |
| A50/A51 Servo Amplifier | Possible faults are:<br><br>Short circuit trip<br>Over bus voltage trip<br>RMS current limit<br>Low level power supply fault<br><br>However, these will vary depending on model of amplifier used in your system. See the appropriate manual for:<br>M160V<br>M100/80QV<br>M4020<br>DS8020 |

**CAUTION: Some of the previously mentioned amplifier faults, such as short circuit trip, RMS current limit and over bus voltage trip, are not latched and can clear themselves. Once again, see appropriate manual for more detailed information.**

| | |
|---|---|
| A48, Brake Control | One of the output motor fuses is open or the brake interlock circuit is active due to a brake cable being disconnected. The brake card can also be configured to trip and latch on any fault generated in the system, requiring a reset to clear. (For more information, see section 10-11, *Brake Control Board*.) |

# CHAPTER 12: SERVICE AND REPAIR

If under warranty, repairs of defective electrical components should not be attempted, *since to do so would void the entire warranty.*

If necessary, any on-site service should be performed by an experienced Aerotech-trained electronics technician

## SECTION 12-1 SHIPMENT

The procedure for shipping equipment back to Aerotech, which is described below, pertains to warranty as well as non-warranty repairs.

1. Before shipping any equipment back to Aerotech, the person making the return must call ahead for a "*Return Authorization Number*". *(Have your serial number on hand when calling.)*
2. The equipment being returned must be encased in a proper cushioning material and enclosed in a cardboard box.

**Call for a "Return Authorization Number" if it is necessary to ship any part to the factory.**

**Warning: Damage due to improper packaging voids warranty!**

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# Appendix 1

# Motorola I/O Channel Specification Manual

Unidex 16 Motion Controller Hardware Manual's Appendix 1, *I/O Channel Specification Manual*, is reprinted by permission of Motorola, Inc.

M68RIOCS(D2)

MARCH 1982

# INPUT/OUTPUT CHANNEL

# SPECIFICATION MANUAL



Second Edition



First Edition December 1981

# PREFACE

The hardware of most computer systems can be partitioned into two major parts: the application-independent part and the application-dependent part.

The application-independent portion typically consists of the CPU, RAM, ROM, timers, and certain diagnostic-related I/O ports. This portion forms a "core" system around which additional hardware is added to meet the specific applications requirements.

The application-dependent portion typically consists of various special purpose I/O devices. In an industrial control application, these may be A/D converters, stepper motor controllers, etc. In a data processing application, these may be printer interfaces, disk interfaces, etc.

The challenge which must be met to produce the most cost-effective system is to produce a low cost "core" system along with modular "add-on" I/O devices which provide only the specific I/O required.

The purpose of the I/O Channel defined in this specification is to provide a communication path through which the "core" system can communicate with its "add-on" I/O devices. The specification is written in sufficient detail to allow a system user to design I/O boards and be confident that they will function properly when connected to the "core" system.

The I/O Channel described by this specification provides the following features:

- 12-bit address bus
- 8-bit bidirectional data bus
- Asynchronous operation
- Up to 2-megabyte transfer rate
- Four interrupt lines
- Reset line
- 4-MHz free running clock line

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

# CHAPTER 1

# I/O CHANNEL SPECIFICATION INTRODUCTION

## 1.1 I/O CHANNEL SPECIFICATION OBJECTIVES

The I/O Channel specification defines an interfacing system whose primary purpose is to provide a high speed data path between I/O slave devices (slaves) and a core system (master). The system has been conceived with the following objectives:

a. To allow the master to perform read and write operations to a slave device without disturbing internal activities of other slave devices.

b. Specify the electrical and mechanical constraints upon the design of the master and slave devices.

c. Specify protocols that define interactions between the master and slave devices.

d. Provide terminology and definitions that describe I/O Channel operation.

## 1.2 I/O CHANNEL SPECIFICATION FORMAT

As an aid to defining or describing the I/O Channel operation, two types of diagrams are used:

a. Timing diagram - shows the relationships of signal line levels versus time.

b. Flow diagram - shows stream of events as they would occur during an I/O Channel operation. The events are stated in words, describing the I/O Channel operations in a sequential manner and, at the same time, showing the interaction between a master and a slave.

## 1.3 SPECIFICATION TERMINOLOGY

The I/O Channel specification describes the bus protocol in terms of levels and transitions on the bus lines.

### 1.3.1 Signal Line States

A signal line is always assumed to be in one of two levels or in transition between these levels. Whenever the term "high" is used, it refers to a high TTL voltage level ($\geq$ + 2.0V). The term "low" refers to a low TTL voltage level ($\leq$ + 0.8V). A signal line is in transition when its voltage is moving between +0.8V and +2.0V.

There are two possible transitions which can occur on a signal line, and these will be referred to as "edges". A rising edge is a low-to-high transition of a signal line. A falling edge is a high-to-low transition of a signal line.

### 1.3.2 Use of Asterisk (*)

To help define usage, signal line mnemonics have an asterisk suffix if the signal is true (or valid) when the signal level is low or the falling edge of the signal initiates an action.

## 1.4 TYPICAL SYSTEM CONFIGURATION

Figure 1-1 illustrates how a system might be configured using a ribbon cable bus I/O Channel. The bus master is typically a computer, but may also include a DMA controller for transferring blocks of data to or from a slave device at high speed.

As shown in Figure 1-1, there are two basic types of slaves on the I/O Channel. Slave Printed Circuit (PC) boards have 64 pin ribbon cable conectors and plug into a 64-pin connector which is crimped onto the ribbon cable. The preferred form factor for these boards is the DIN standard. These boards are powered through their 64 pin connectors and may draw +5V and ±12V from the bus. The length of the 64 wire ribbon cable running from the power source (usually the master) to the powered slave boards is subject to the limitations described in Figure 3-2.

When the slave PC boards are located at too great a distance from the master, power may be provided by a source close to their location. Figure 1-2 illustrates how this might be done.

The second type of slave is called a subsystem slave. It can be identified by the fact that it includes its own power supply. (It is usually also housed in some sort of enclosure.)

A subsystem slave has two 50-pin ribbon cable connectors on its interface panel. In addition, it provides access to an internally-mounted terminator board to allow it to be configured as the last slave on the cable (terminators enabled).

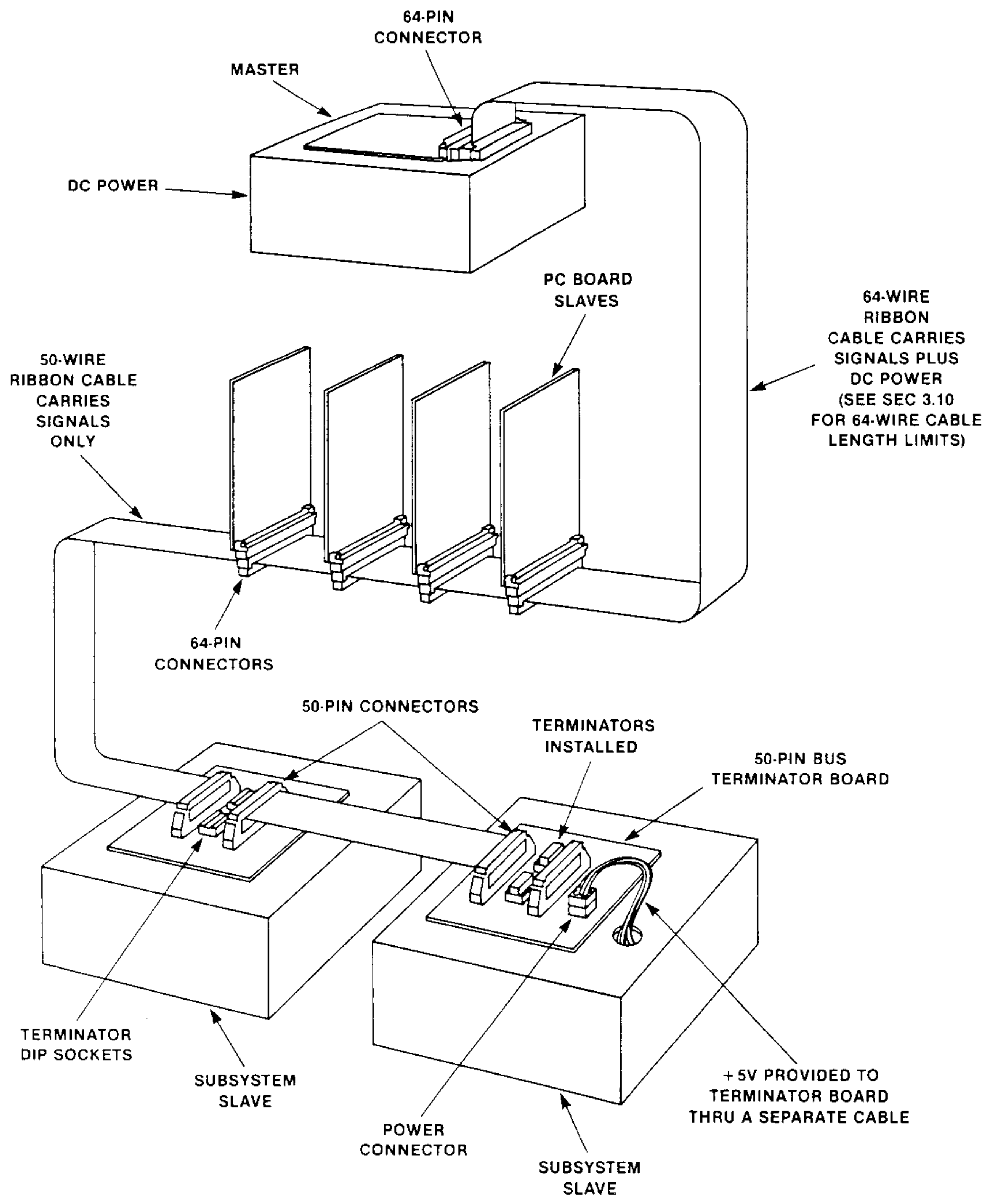



FIGURE 1-1. Typical I/O Channel Configuration

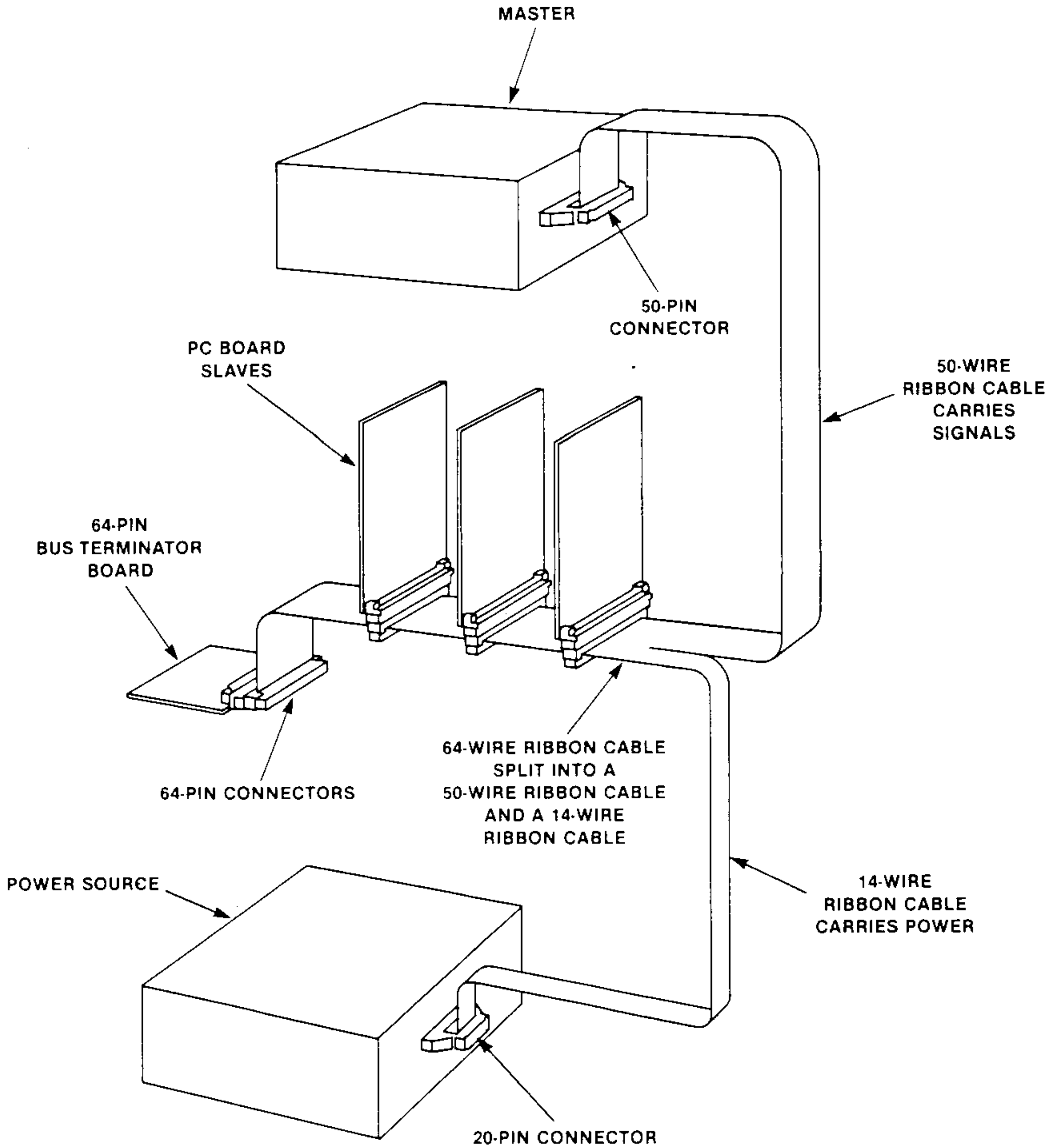



FIGURE 1-2. Alternate Power Wiring Configuration

# CHAPTER 2

# I/O CHANNEL SIGNALS

## 2.1 I/O CHANNEL SIGNAL LINES

The following identify the I/O Channel signal lines:

| | |
|---|---|
| A0-A11 | Address channel (bits 0-11) |
| D0-D7 | Data channel (bits 0-7) |
| WT* | Write |
| STB* | Strobe |
| XACK* | Transfer Acknowledge |
| CLK | Clock |
| IORES* | Input Output Reset |
| INT1*-INT4* | Interrupt (lines 1-4) |

## 2.2 DATA TRANSFER PROTOCOL

All data transfers on the I/O Channel are between the master and a slave, and are initiated by the master. All data transfers are asynchronous and rely on two interlocked signal lines, STB* and XACK*. STB* is generated by the master and initiates a data transfer. XACK* is generated by the addressed slave to indicate that the data transfer has been acknowledged.

### 2.2.1 Write Cycle Sequence

**MASTER**

INITIATE CYCLE

1) Place address and data on channel, and drive WT* line low
2) Drive STB* line low

**SLAVE**

RESPOND

1) Wait for STB* low
2) Read address from channel
3) Detect WT* low
4) If addressed location is this device, then
   a) Store data
   b) Drive XACK* line low

**MASTER**

WAIT FOR TRANSFER ACKNOWLEDGE

1) Wait for XACK*low
2) Drive STB* line high

**SLAVE**

TERMINATE TRANSFER ACKNOWLEDGE

1) Wait for STB* line high
2) Release XACK* line

**MASTER**

TERMINATE CYCLE

1) Wait for XACK* high

INITIATE NEXT CYCLE

2.2.2 Read Cycle Sequence

MASTER | SLAVE

INITIATE CYCLE (MASTER)

1) Place address on channel and drive WT* line high
2) Drive STB* line low

RESPOND (SLAVE)

1) Wait for STB* low
2) Read address from channel
3) Detect WT* high
4) If addressed location is this device, then
   a) Place data on channel
   b) Drive XACK* line low

WAIT FOR TRANSFER ACKNOWLEDGE (MASTER)

1) Wait for XACK*low
2) Receive data
3) Drive STB* line high

TERMINATE TRANSFER ACKNOWLEDGE (SLAVE)

1) Wait for STB* line high
2) Turn off data drivers
3) Release XACK* line

TERMINATE CYCLE (MASTER)

1) Wait for XACK* high

INITIATE NEXT CYCLE

## 2.3 TIMING DIAGRAMS

The detailed timing diagrams describe the timing relationships for data transfers on the I/O Channel. Two separate sets of timing diagrams — one for the master and one for the slave -- take into account signal skew and settling times, and provide the designer with an exact definition of his timing constraints and guarantees.

The I/O Channel is a passive ribbon cable, and capacitive loading of the signal lines causes a degradation of rise and fall times. This degradation may cause the signals to skew as they propagate down the I/O Channel. The maximum skew between two lines on the channel occurs when one line has minimum loading and another has maximum loading.

Data lines on the I/O Channel are separated from other channel signals by a ground line to minimize cross-talk between the data lines and other channel signals. However, the data lines are not shielded from each other, and cross-talk may occur between data lines. The same is true for the address lines.

The I/O Channel is designed to allow up to 75 nanoseconds total skew and settling time (SKEW + SETTLING TIME = 75 ns MAX). As an example, the master is required to wait 125 nanoseconds after placing a new address on the I/O Channel before driving the STB* line low. However, because of skew and settling times, the addresses received by the slave are guaranteed to be stable and valid only 50 nanoseconds before the device senses that the STB* line has been driven low by the master.

### 2.3.1 Master Parameters

Figure 2-1 illustrates the master parameters, which are identified as follows:

1. Address set-up time. Address lines must be stable and valid for the minimum set-up time before STB* is driven low.
2. To guarantee a read cycle, WT* line must be high for the minimum set-up time before STB* is driven low.
3. Read data set-up time guaranteeing that slave data will be stable and valid for the minimum set-up time before the master receives low XACK*.
4. Addresses must remain valid and stable until low XACK* is received.
5. WT* line must remain valid and stable until low XACK* is received.
6. Once driven low, STB* must remain low until low XACK* is received.
7. Time guaranteeing that data read from the slave remains stable and valid until the master drives STB* high.

8. To ensure a write cycle, the WT* line must be low for the minimum set-up time before STB* can be driven to a low level.

9. The master cannot drive data lines until receiving XACK* high. This indicates that the slave addressed during the previous read cycle is no longer driving the data channel lines.

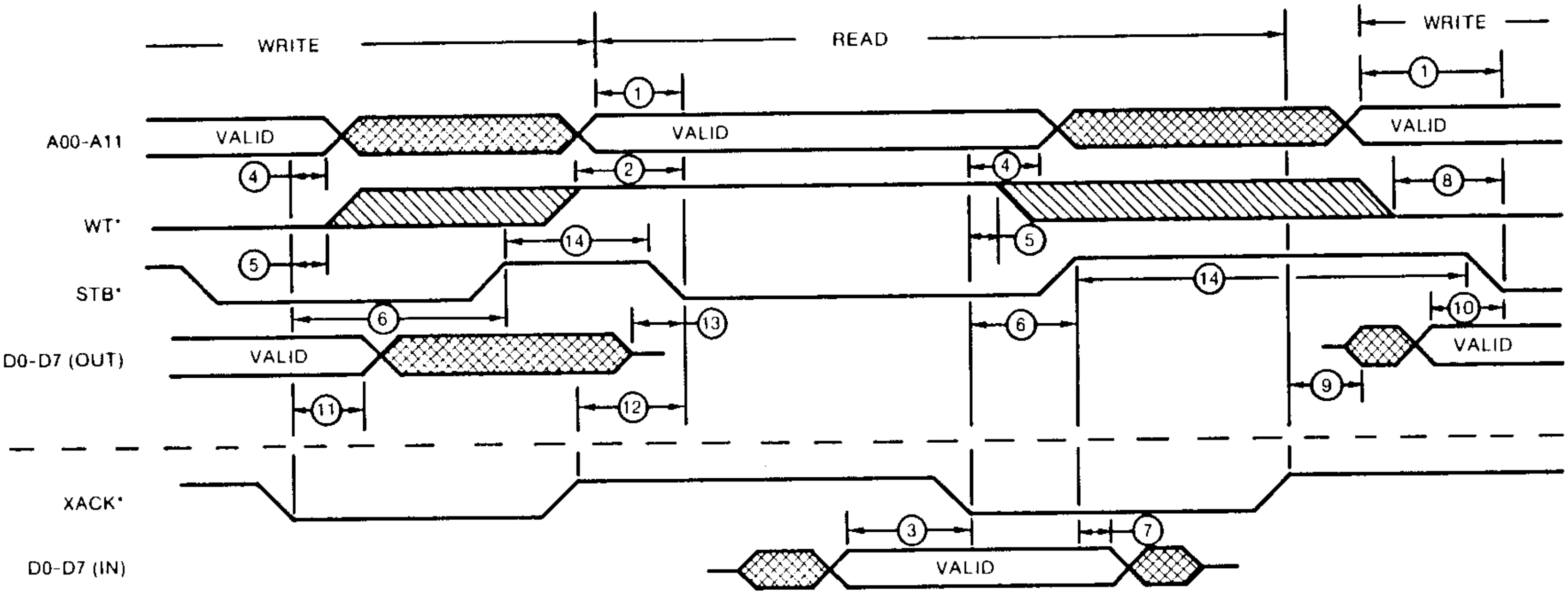
10. Minimum set-up time for data to be stable and valid before STB* can be driven low.

11. Data must remain stable and valid until low XACK* is received.

12. Time required for the master to receive XACK* high before the master can drive STB* low.

13. When going from a write to a read cycle, the master must release the data channel before driving STB* low.

14. The master must drive STB* line high for this minimum time between cycles.




| NUMBER | DESCRIPTION | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| 1 | ADDRESS VALID TO STB* LOW | 125 | — | NS | 1, 2 |
| 2 | WT* HIGH TO STB* LOW | 125 | — | NS | 2 |
| 3 | DATA-IN VALID TO XACK* LOW | 50 | — | NS | 2 |
| 4 | XACK* LOW TO ADDRESS INVALID | 0 | — | — | 1, 2 |
| 5 | XACK* LOW TO WT* INVALID | 0 | — | — | 1, 2 |
| 6 | XACK* LOW TO STB* HIGH | 0 | 2.0 | US | 1, 2 |
| 7 | STB* HIGH TO DATA-IN INVALID | 0 | — | — | 2 |
| 8 | WT* LOW TO STB* LOW | 125 | — | NS | 1 |
| 9 | XACK* HIGH TO DATA-OUT DRIVEN | 0 | — | — | 1 |
| 10 | DATA-OUT VALID TO STB* LOW | 125 | — | NS | 1 |
| 11 | XACK* LOW TO DATA-OUT INVALID | 0 | — | — | 1 |
| 12 | XACK* HIGH TO STB* LOW | 0 | — | — | 2 |
| 13 | DATA-OUT HI-Z TO STB* LOW | 0 | — | — | 2 |
| 14 | STB* HIGH TIME | 125 | — | NS | 1, 2 |

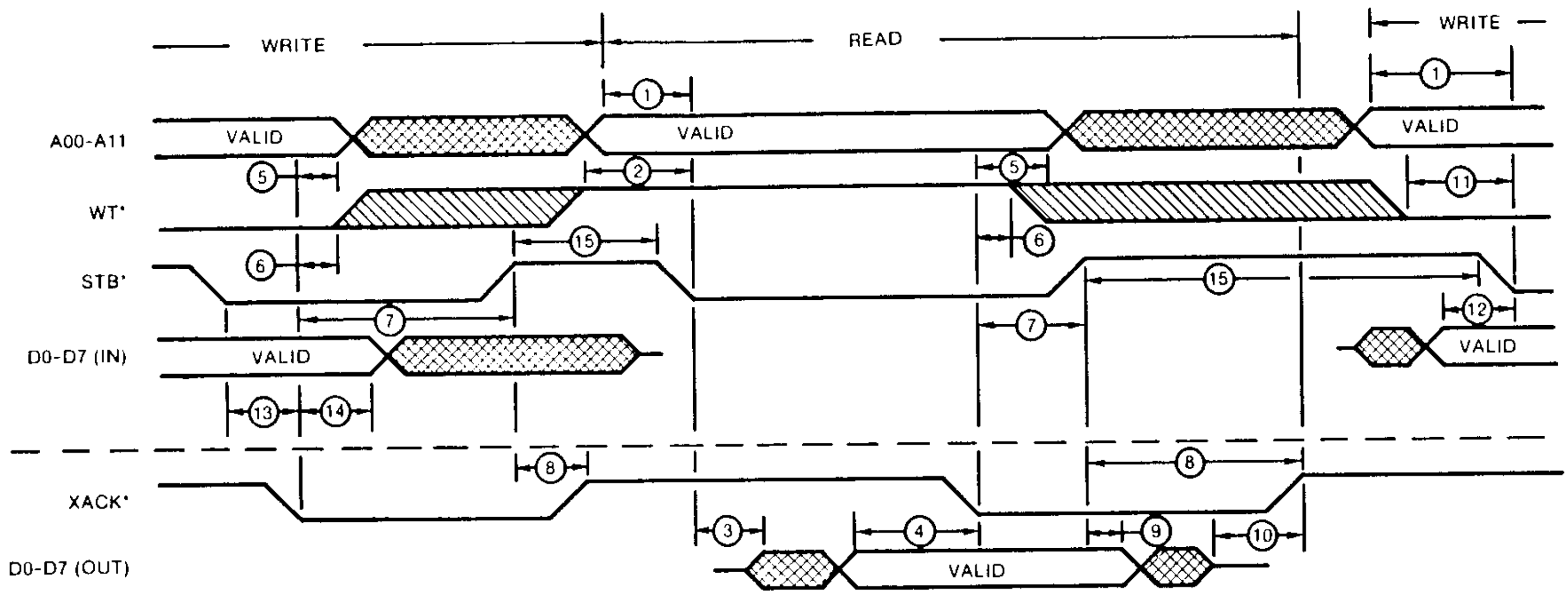
NOTES: 1. WRITE CYCLE
2. READ CYCLE

FIGURE 2-1. Master I/O Channel Timing Diagram

### 2.3.2 Slave Parameters

Figure 2-2 illustrates the slave parameters, which are identified as follows:

1. Minimum guaranteed slave address set-up time.
2. WT* line guaranteed high for this minimum time before low STB* is received.
3. Earliest time slave data channel drivers can turn on after receiving low STB*.
4. Data must be stable and valid for this minimum time before XACK* can be driven low.
5. Parameter guarantees addresses remain valid until XACK* is driven low.
6. Parameter guarantees WT* line will not change levels until XACK* is driven low.
7. STB* guaranteed to remain low until XACK* is driven low.
8. XACK* must be driven low until high STB* is received.
9. Data must remain valid until high STB* is received.
10. Slave data channel drivers must turn off before releasing XACK* line.
11. WT* line guaranteed to be low for this minimum time before low STB* is received.
12. Data guaranteed stable and valid for this minimum time before low STB* is received.
13. XACK* cannot be driven low for this minimum time after low STB* is received.
14. Parameter guarantees that data-in will not change until XACK* is driven low.
15. High STB* line is guaranteed for this minimum time.




| NUMBER | DESCRIPTION | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| 1 | ADDRESS VALID TO STB* LOW | 50 | — | NS | 1, 2 |
| 2 | WT* HIGH TO STB* LOW | 50 | — | NS | 2 |
| 3 | STB* LOW TO DATA-OUT DRIVEN | 0 | — | — | 2 |
| 4 | DATA-OUT VALID TO XACK* LOW | 125 | — | NS | 2 |
| 5 | XACK* LOW TO ADDRESS INVALID | 0 | — | — | 1, 2 |
| 6 | XACK* LOW TO WT* INVALID | 0 | — | — | 1, 2 |
| 7 | XACK* LOW TO STB* HIGH | 0 | — | — | 1, 2 |
| 8 | STB* HIGH TO XACK* HIGH | 0 | 1.0 | US | 1, 2 |
| 9 | STB* HIGH TO DATA-OUT INVALID | 0 | — | — | 2 |
| 10 | DATA-OUT HI-Z TO XACK* HIGH | 0 | — | — | 2 |
| 11 | WT* LOW TO STB* LOW | 50 | — | NS | 1 |
| 12 | DATA-IN VALID TO STB* LOW | 50 | — | NS | 1 |
| 13 | STB* LOW TO XACK* LOW | 50 | 2000 | NS | 1, 2 |
| 14 | XACK* LOW TO DATA-IN INVALID | 0 | — | — | 1 |
| 15 | STB* HIGH TIME | 50 | — | NS | 1, 2 |

NOTES: 1. WRITE CYCLE
2. READ CYCLE

FIGURE 2-2. Slave I/O Channel Timing Diagram

2.3.3 Interrupts

Slaves may interrupt the master by driving low one of the four prioritized interrupt lines (INT1*-INT4*). INT1* is the lowest priority interrupt. INT4* is the highest priority interrupt.

Any number of slaves can generate an interrupt at any given time. However, when a slave drives an interrupt line low, it must continue to drive the interrupt line low until the master acknowledges the interrupt. Any slave that is capable of generating an interrupt must also contain at least one status byte of one to eight bits in length that is readable by the master at a pre-determined address. The state of the status byte indicates whether or not that slave has a pending interrupt, and can also contain additional information about the cause of the interrupt or the action required to service or clear the interrupt.

There are three ways in which interrupts may be cleared on the I/O Channel:

a. Reset clears interrupt.
b. Read clears interrupt.
c. Write clears interrupt.

2.3.3.1 Reset Clears Interrupt. In this mode, all interrupts that are to be removed by a reset must be cleared within ten microseconds after the IORES* line on the I/O Channel goes low. This is an initialization function. No record of past interrupt status is provided after initialization.

2.3.3.2 Read Clears Interrupt. In this mode, when the master reads data from a specific address of the interrupting slave (the addressed location may be the status byte), the slave must stop driving the particular interrupt line low (INT1*-INT4*) within three microseconds after receiving STB* low. This byte is read just like any other byte of a read operation, and must conform to all timing and handshake sequencing of a read cycle.

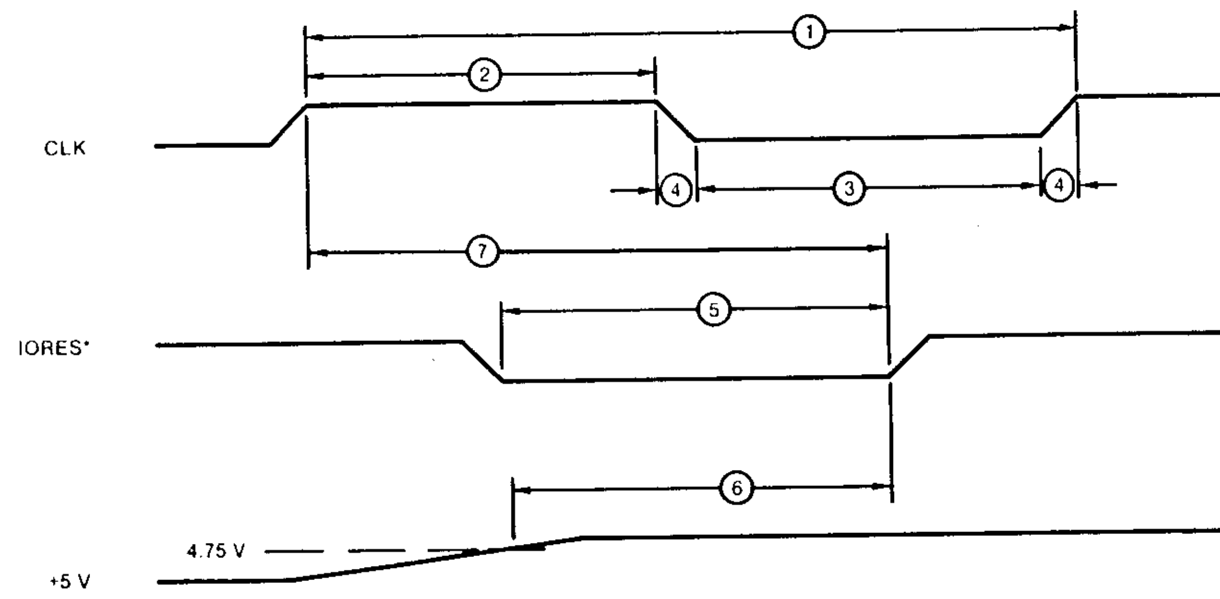
2.3.3.3 Write Clears Interrupt. In this mode, when the master writes to a specified location on the interrupting slave, the slave must stop driving the particular interrupt line (INT1*-INT4*) within three microseconds after receiving STB* low. This byte is written just like any other byte of a write operation, and must conform to all timing and handshake sequencing of a write cycle.

2.3.4 Utilities

Two additional signals -- clock and reset -- are included on the I/O Channel.

2.3.4.1 Clock. The CLK line is a free-running, 4-MHz (nominal) signal that may be used for miscellaneous timing by slaves. There is no relationship between the CLK line and any other timing on the I/O Channel.

2.3.4.2 Input Output Reset. The IORES* line, when driven low by the master on a power-up reset circuit, is used to place slaves into a pre-determined state.




| NUMBER | DESCRIPTION | MIN | MAX | UNITS | NOTES |
|---|---|---|---|---|---|
| 1 | CLOCK PERIOD | 247 | 253 | NS | |
| 2 | CLOCK PULSE WIDTH HIGH | 100 | — | NS | |
| 3 | CLOCK PULSE WIDTH LOW | 100 | — | NS | |
| 4 | CLOCK RISE AND FALL TIMES | — | 25 | NS | 2 |
| 5 | RESET PULSE WIDTH LOW | 10 | — | US | 3 |
| 6 | POWER—UP TO IORES* HIGH | 100 | — | MS | 4 |
| 7 | CLOCK STABLE TO IORES* HIGH | 10 | — | US | 4 |

NOTES:
1. A HIGH SIGNAL IS 2 VOLTS. A LOW SIGNAL IS 0.8 VOLTS.
2. RISE/FALL TIMES ARE MEASURED BETWEEN 0.8 VOLTS AND 2.0 VOLTS.
3. APPLIES ONLY WHEN IORES* IS NOT THE RESULT OF POWER-UP.
4. APPLIES ONLY DURING POWER-UP INITIALIZATION.

FIGURE 2-3. Utility Timing Diagram

CHAPTER 3

# ELECTRICAL AND MECHANICAL SPECIFICATIONS

## 3.1 DRIVER DEFINITIONS

a. Totem-pole: An active driver in both states which sinks current in the low state and souces current in the high state.

b. Three-state: Similar to totem-pole driver except that it can go to a high impedance state (drivers turned off). Three-state drivers are used for lines that can be driven by several devices at different points on the channel. Only one driver can be active at any one time (e.g., data channel).

c. Open-collector: Sinks current in the low state but sources no current in the high state.

## 3.2 I/O CHANNEL DRIVER PARAMETERS

The I/O Channel driver parameters are listed below:

| DRIVER TYPE | PARAMETERS | MIN. | MAX. | UNIT | TEST CONDITION |
|---|---|---|---|---|---|
| Totem-pole | Low state ($V_{OL}$) | | 0.55 | V | $I_{OL}$ = 24 mA |
| | High state ($V_{OH}$) | 2.4 | | V | $I_{OH}$ = 2.6 mA |
| Three-state | Low state ($V_{OL}$) | | 0.55 | V | $I_{OL}$ = 24 mA |
| | High state ($V_{OH}$) | 2.4 | | V | $I_{OH}$ = 2.6 mA |
| | Off current ($I_{OZH}$) | | 50 | uA | $V_{OUT}$ = 2.4 V |
| | Off current ($I_{OZL}$) | | -50 | uA | $V_{OUT}$ = 0.4 V |
| Open-collector | Low state ($V_{OL}$) | | 0.55 | V | $I_{OL}$ = 24 mA |
| | High state ($I_{OH}$) | | 250 | uA | $V_{OH}$ = 5.5 V |

### 3.3 I/O CHANNEL RECEIVER PARAMETERS

The I/O Channel receiver parameters are listed below:

| PARAMETER | MIN. | MAX. | UNIT | TEST CONDITION |
|---|---|---|---|---|
| Input low voltage ($V_{IL}$) | | 0.8 | V | |
| Input high voltage ($V_{IH}$) | 2.0 | | V | |
| Input low current ($I_{IL}$) | | -0.4 | mA | $V_{IN}$ = 0.4 V |
| Input high current ($I_{IH}$) | | 50 | uA | $V_{IN}$ = 2.7 V |

NOTE: All channel receivers should have input clamp diode circuits to prevent excessive negative voltage excursions.

## 3.4 SIGNAL LINE DRIVER/RECEIVER DESCRIPTIONS

The signal line driver/receiver descriptions are as follows:

| SIGNAL NAME | SIGNAL MNEMONIC | DRIVER TYPE | RECOMMENDED DRIVER PART # | RECOMMENDED RECEIVER PART # |
|---|---|---|---|---|
| Address | A0-A11 | Totem-pole or Three-state | 74LS244 | 74LS244<br>74LS373 |
| Data | D0-D7 | Three-state | 74LS244<br>74LS245<br>74LS373 | 74LS244<br>74LS245<br>74LS373 |
| Write | WT* | Totem-pole or Three-state | 74LS244<br>74LS373 | 74LS14 |
| Strobe | STB* | Totem-pole or Three-state | 74LS244<br>74LS373 | 74LS14 |
| Transfer Acknowledge | XACK* | Open-collector | 74LS38<br>74LS33 | 74LS14 |
| Input Output Reset | IORES* | Open-collector | 74LS38<br>74LS33 | 74LS14 |
| Interrupt | INT1*-INT4* | Open-collector | 74LS38<br>74LS33 | 74LS14 |
| Clock | CLK | Totem-pole or Three-state | 74LS244 | 74LS244<br>74LS373<br>74LS14 |

3.5 TERMINATION NETWORKS

Resistor terminators serve two purposes:

a. Reflection and ringing reduction
b. High state pull-up for open-collector drivers

The standard termination resistor network is shown in Figure 3-1.

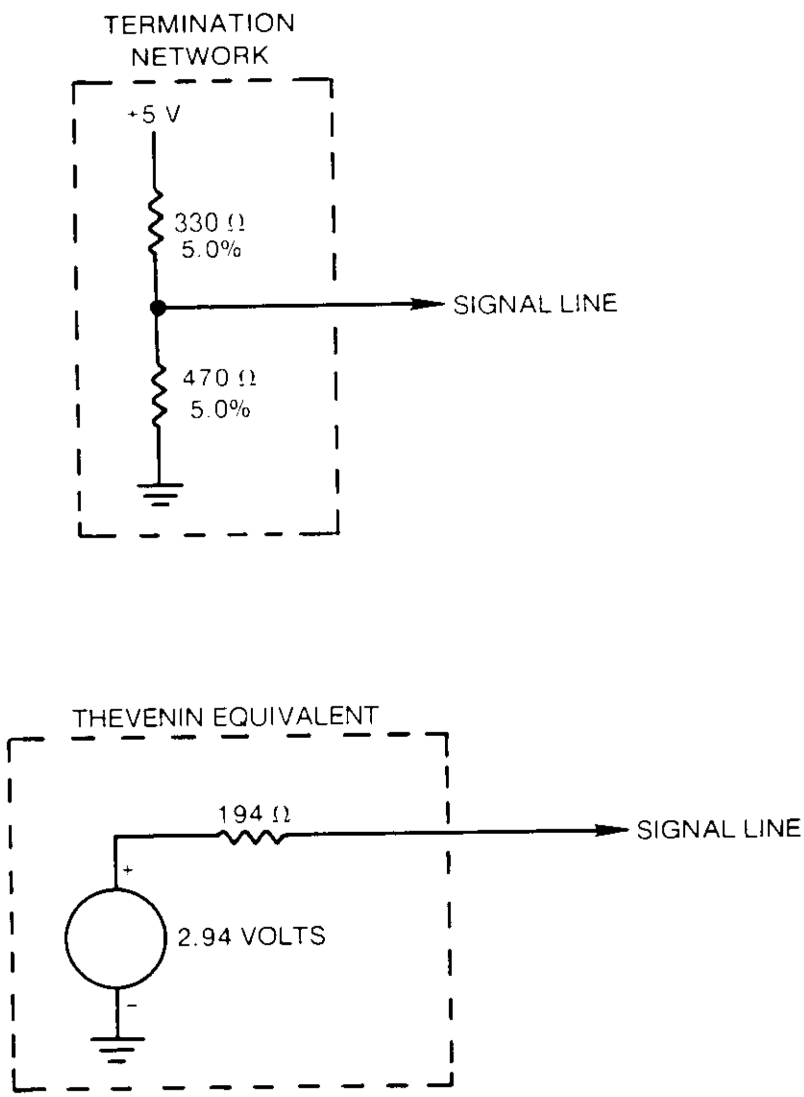



FIGURE 3-1. Termination Resistor Network

The master is always located at one end of the cable and provides terminations for INT1*-INT4* and XACK*. Provision for terminating all other lines of the I/O Channel should be provided at the slave end of the cable for ribbon lengths greater than 18 inches to provide terminations for the address, data, clock, and reset lines. The IORES* line should also be pulled high by the master (via a 4.7K ohm ±5% resistor to +5 Vdc). This keeps the IORES* line from floating in non-terminated systems.

## 3.6 BOARD LEVEL LOADING

Each slave may load each I/O Channel signal line with no more than one LSTTL input load, one three-state or open-collector output load, and 30 picofarads of capacitance.

## 3.7 I/O CHANNEL RIBBON CABLE CHARACTERISTICS

The I/O Channel is designed primarily for ribbon cable interconnection, but is not restricted to ribbon cable. For example, a PC board might be used for interconnection if its characteristics matched those of the ribbon cable as shown below. The specifications which follow, along with the terminators, timing, and board-level loading restrictions, allow 16 slaves to communicate with a master over a distance of 12 feet on a ribbon cable.

| PARAMETER | RIBBON CABLE SPECIFICATION |
|---|---|
| Center spacing | .050 inch |
| Conductor | Stranded copper |
| Conductor size | 28 AWG |
| Stranding | 7 X 36 |
| Conductor quantity | 50 or 64 |
| Impedance | $\geq$ 100 ohm |
| Capacitance (pf/ft) | $\leq$ 20 |
| Inductance (uH/ft) | $\leq$ .25 |
| (ohms/1000 ft @ 20° C) | $\leq$ 70 |
| Propagation delay (ns/ft) | $\leq$ 1.5 |

Recommended cables:

| | |
|---|---|
| 3M | 3365/50 or 3365/64 |
| Hitachi | EG-2850 or EG-2864 |

3.8 PIN ASSIGNMENTS FOR I/O CHANNEL

The pin assignments for the I/O Channel are as follows:

| DIN CONNECTOR PIN | 3M CONNECTOR PIN | MNEMONIC | DIN CONNECTOR PIN | 3M CONNECTOR PIN | MNEMONIC |
|---|---|---|---|---|---|
| C1 | 1 | INT4* | A1 | 2 | GROUND |
| C2 | 3 | INT3* | A2 | 4 | GROUND |
| C3 | 5 | INT2* | A3 | 6 | GROUND |
| C4 | 7 | INT1* | A4 | 8 | GROUND |
| C5 | 9 | IORES* | A5 | 10 | GROUND |
| C6 | 11 | XACK* | A6 | 12 | GROUND |
| C7 | 13 | CLK | A7 | 14 | GROUND |
| C8 | 15 | (Reserved) | A8 | 16 | GROUND |
| C9 | 17 | (Reserved) | A9 | 18 | GROUND |
| C10 | 19 | (Reserved) | A10 | 20 | GROUND |
| C11 | 21 | GROUND | A11 | 22 | A11 |
| C12 | 23 | A9 | A12 | 24 | A10 |
| C13 | 25 | A7 | A13 | 26 | A8 |
| C14 | 27 | A5 | A14 | 28 | A6 |
| C15 | 29 | A3 | A15 | 30 | A4 |
| C16 | 31 | A1 | A16 | 32 | A2 |
| C17 | 33 | A0 | A17 | 34 | GROUND |
| C18 | 35 | STB* | A18 | 36 | GROUND |
| C19 | 37 | WT* | A19 | 38 | GROUND |
| C20 | 39 | GROUND | A20 | 40 | D7 |
| C21 | 41 | D5 | A21 | 42 | D6 |
| C22 | 43 | D3 | A22 | 44 | D4 |
| C23 | 45 | D1 | A23 | 46 | D2 |
| C24 | 47 | D0 | A24 | 48 | GROUND |
| C25 | 49 | GROUND | A25 | 50 | GROUND |
| C26 | | -12 Volts | A26 | | -12 Volts |
| C27 | | (Reserved) | A27 | | (Reserved) |
| C28 | | +12 Volts | A28 | | +12 Volts |
| C29 | | +5 Volts | A29 | | +5 Volts |
| C30 | | +5 Volts | A30 | | +5 Volts |
| C31 | | GROUND | A31 | | GROUND |
| C32 | | GROUND | A32 | | GROUND |

NOTE: Where 50-pin ribbon cable is used, the 14 power lines shown at the bottom of this table are not connected by the cable.

## 3.9 CONNECTORS

Figure 3-2 is an illustration of the DIN 41612 standard 64-pin connector. PC board slaves use the male connector; the backplane/ribbon cable uses the female connector.

Masters are not required to provide power on the 14 dc power pins; but if they do, they should be interfaced through a DIN connector (the master uses the male connector where the cable has a female). When a master does not provide power, it should be interfaced using a 50-pin ribbon cable connector.

Figure 3-3 is an illustration of the 50-pin ribbon cable connector. This is used by masters which do not supply power and by slaves which do not derive their power from the ribbon cable (i.e., subsystem slaves). In each case, the unit connecting to the bus should use a male connector, while female connectors are used on the ribbon cable.

## 3.10 POWER DISTRIBUTION

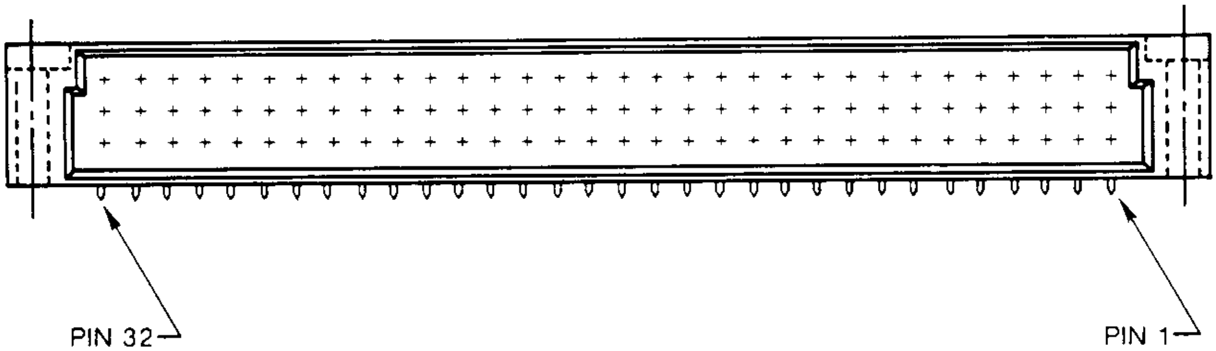
There are many possible methods for power distribution on the I/O Channel. Figure 3-4 shows a configuration where several power sources are used to power the individual units. The rule of thumb to be followed is that a 50-pin ribbon cable is used to connect devices which do not share a power source, and a 64-pin ribbon cable is used where a power source is shared.

The number of PC board slaves which can be supported over a length of 64-pin ribbon cable is dependent upon two factors: the amount of current drawn by each board and the cable length between each board and its power source. Each additional board added to the 64-wire cable causes additional load current to be drawn and thus lowers the voltage provided to all other boards.

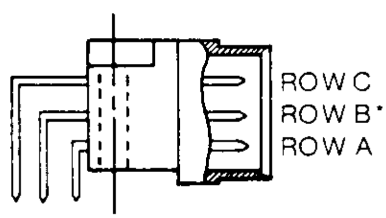
Since the loads may be distributed evenly along the length of the cable or may be clustered at one point, the calculation of the resulting dc voltage at each board may be fairly complex.

If the boards are all clustered near one point, it is possible to determine the maximum cable length by referring to Figure 3-5. The load current for all of the boards is summed and found on the vertical axis. The maximum permissable cable length from the power source can then read from the horizontal axis.

While this same method may be used where boards are distributed along the length of the cable, it may give a smaller number of boards than could actually be supported. By using the dc resistance value of 0.070 ohms/ft and by assuming a maximum allowable drop of 0.1 V along the cable, the user can calculate a more realistic limit.




SLAVE BOARD CONNECTOR
DIN SPEC 0041612




*ROW B IS NOT USED
AND IS OPTIONAL.

FIGURE 3-2. Slave Board Connector

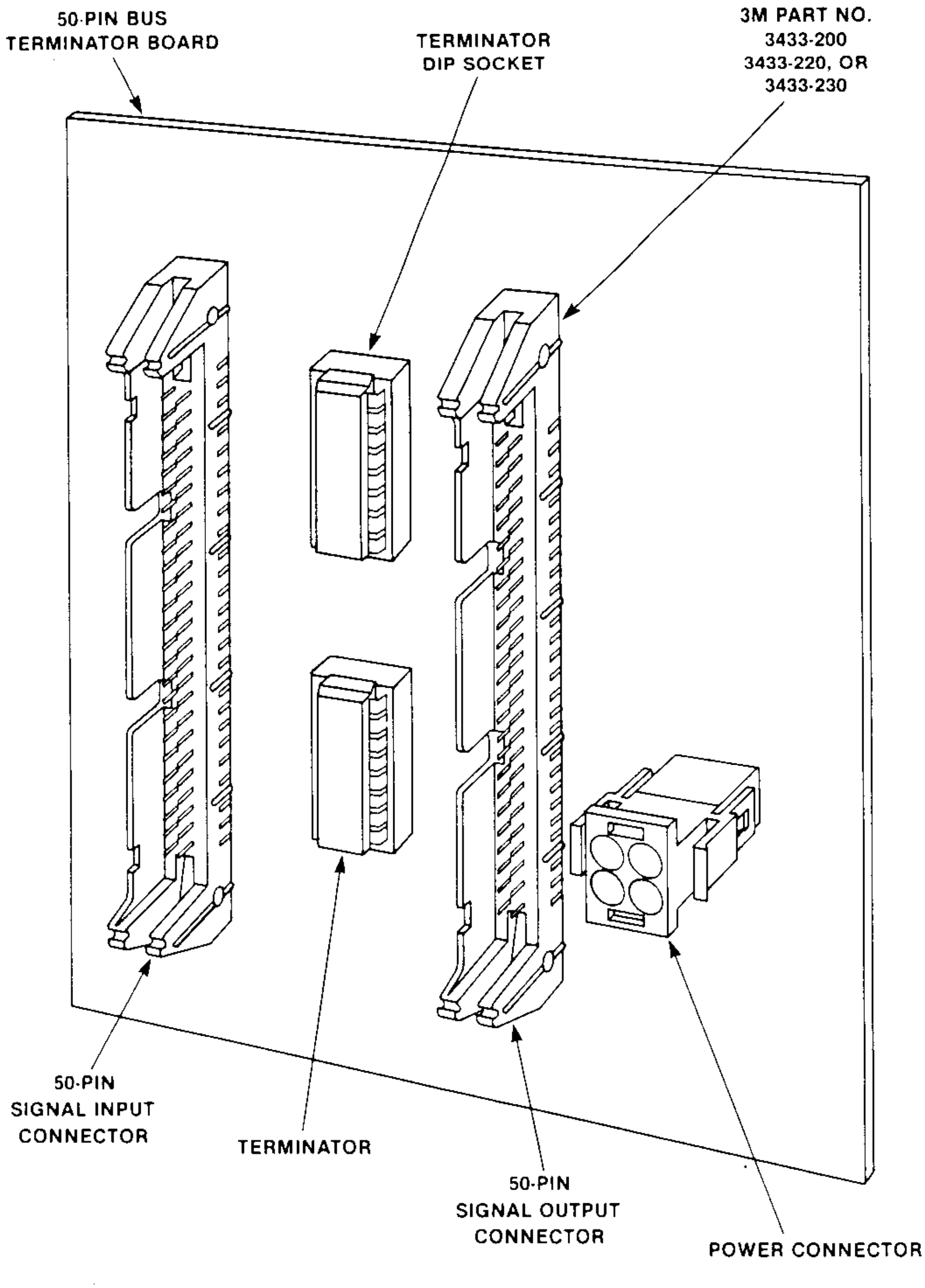



FIGURE 3-3. Subsystem Slave Connector Configuration

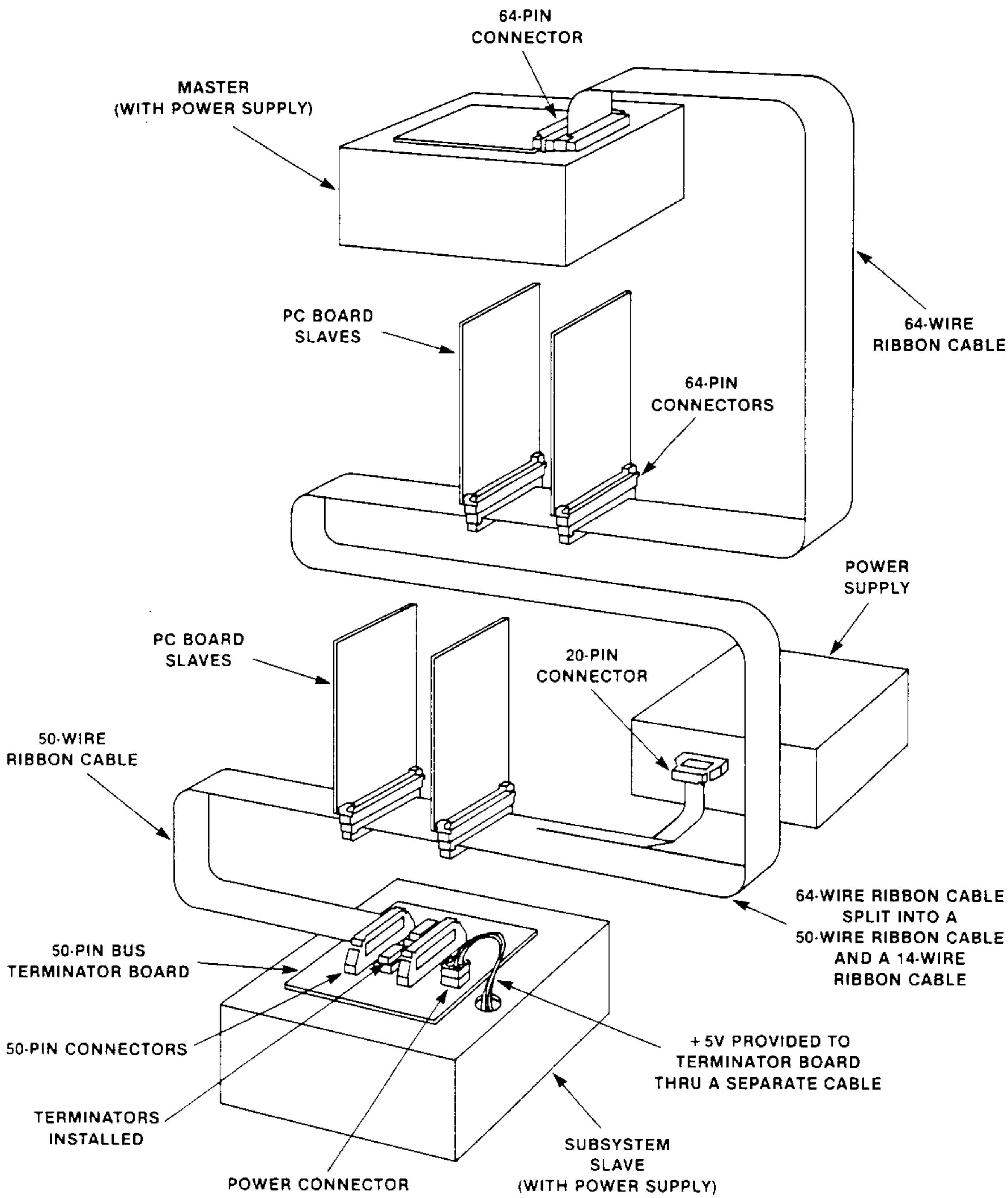



FIGURE 3-4. Multi-Source Power Distribution

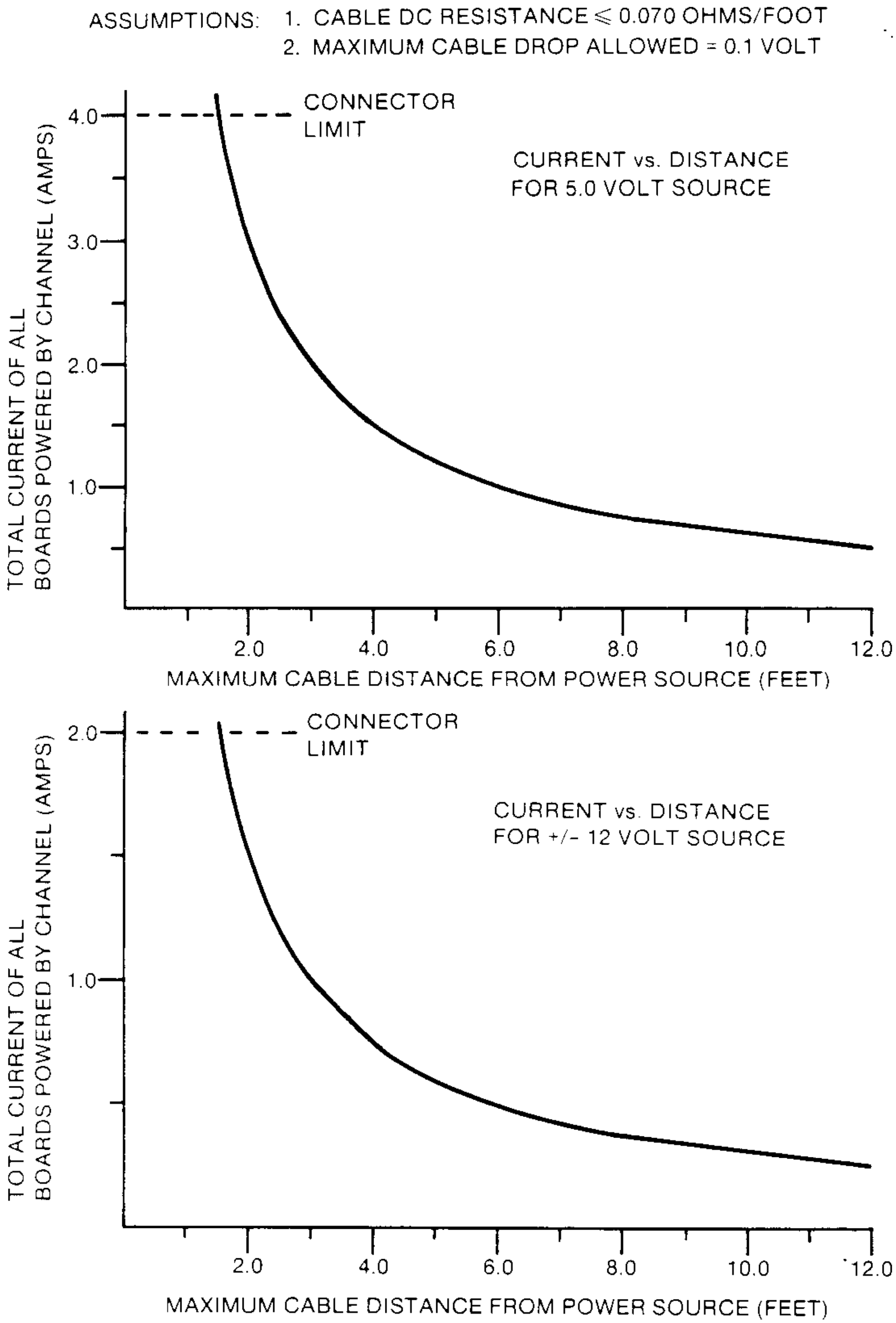



FIGURE 3-5. I/O Channel Current Loading

# APPENDIX A

## RECOMMENDED SLAVE ADDRESSING METHOD

Each slave on the I/O Channel can be assigned to one of nine categories:

1-byte slaves
2-byte slaves
4-byte slaves
8-byte slaves
16-byte slaves
32-byte slaves
64-byte slaves
128-byte slaves
256-byte slaves

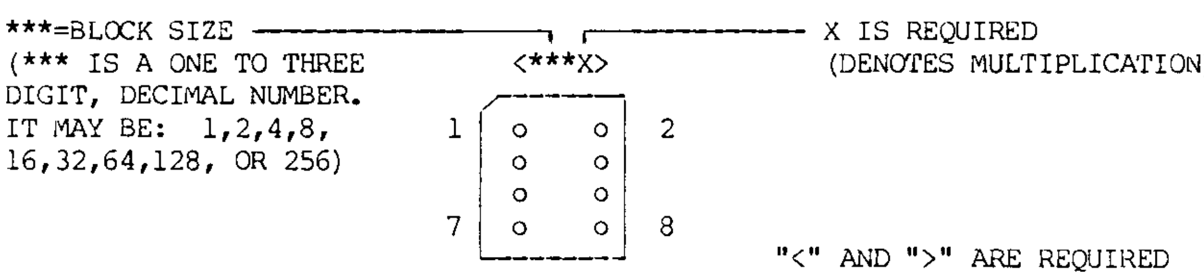
For each of these categories, there are 16 blocks of addresses reserved in the memory map, each with an associated block number (BN0-BN15).

Figure 1 illustrates how these blocks are arranged in the map for 1- , 2- , and 4-byte slaves. The method illustrated can be summarized by the following rule:

> An "n" byte slave should be provided with jumpering to allow it to be placed in any one of 16 n-byte blocks, starting at memory location $000.

The standard jumpering method to accomplish this is described in the following paragraphs.

All I/O Channel slave boards will use a 2x4 header (Microsystems part number 28NW9802C43) for selecting their base address in the I/O Channel memory map. Each board's block size will be silkscreened directly above its 2x4 header (block select header), as shown in the figure.




A board's block size will be the number of bytes of the I/O Channel memory map used by the board, rounded up to the nearest value in the following set of numbers: 1,2,4,8,16,32,64,128,256. For example, if a board has 20 consecutive one-byte registers, then its block size is 32 (the remaining 12 locations may contain redundantly-decoded registers or they may remain unused). Therefore, the symbol <32X> should be placed above its block select header. Note that the largest allowable block size is 256.

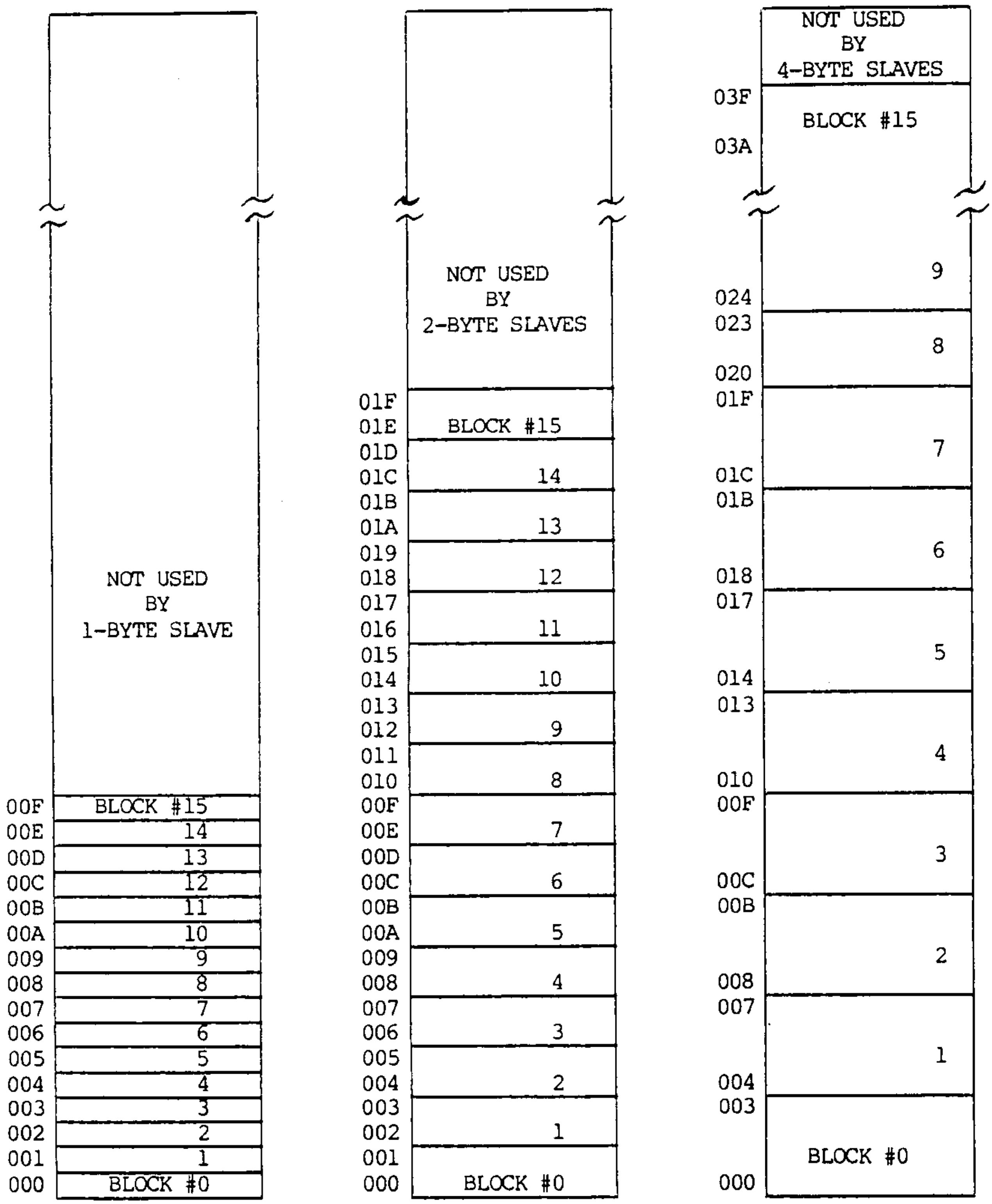
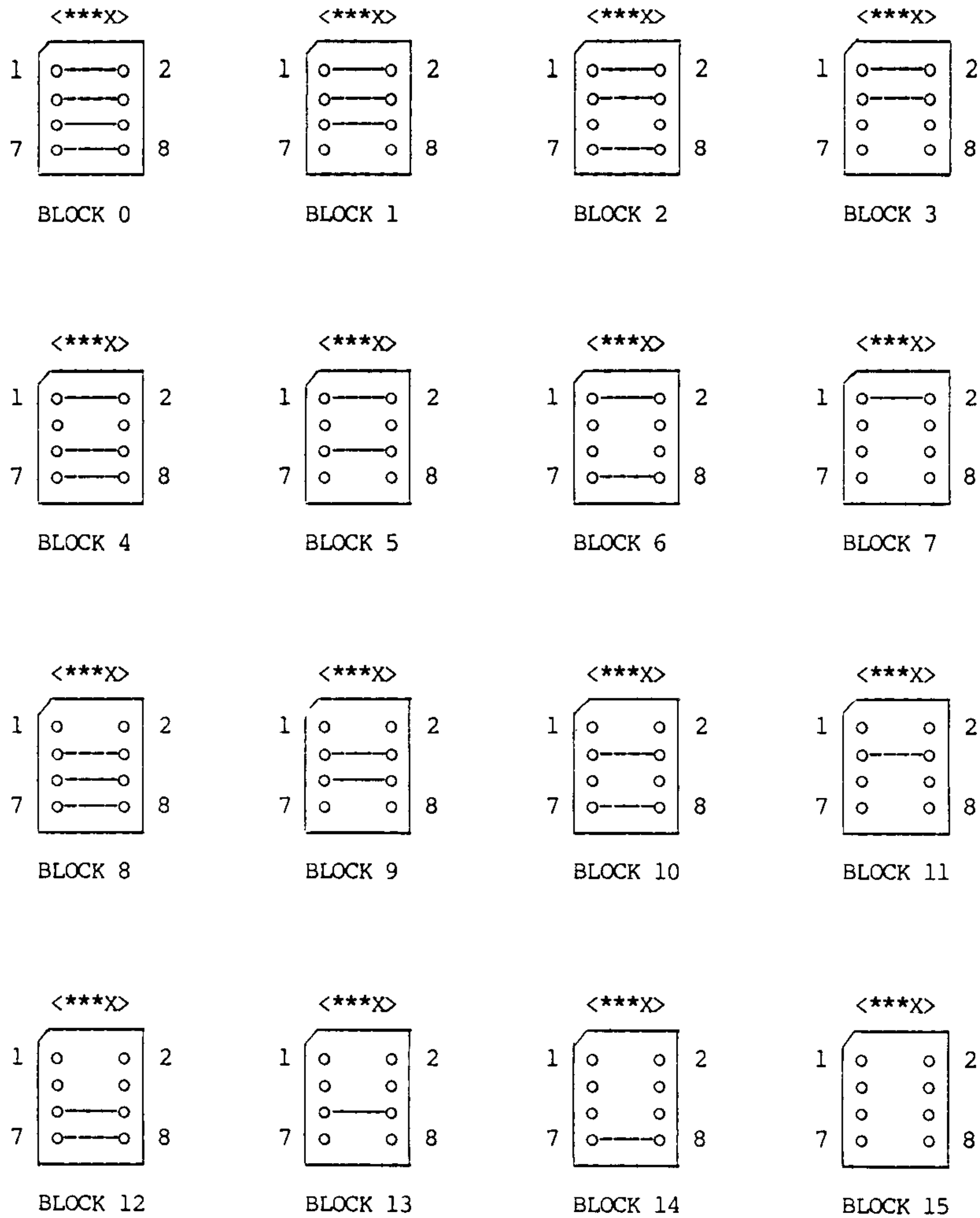
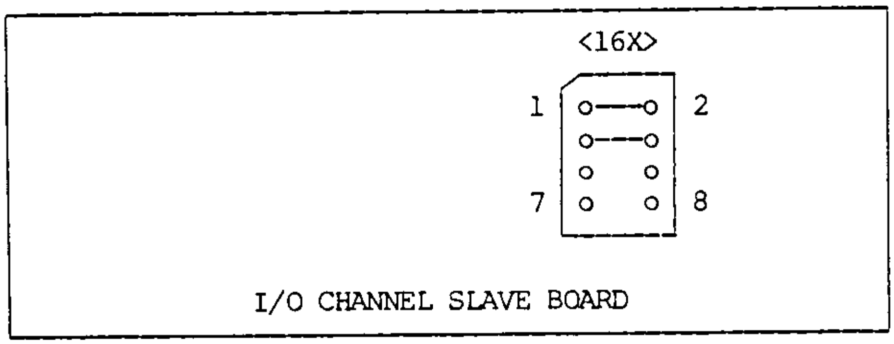



FIGURE 1. Memory Map Placements for 1- ,2- , and 4-Byte Slaves

Each possible jumper configuration of the block select header is assigned a block number. The block select header configuration to block number correspondence is as follows:



The board address decoding will be implemented such that (block number) X (block size) = (base address). For example, a board jumpered in the following manner has a base address of 48 since its block size is 16 and its block select header is configured for block number 3.




16 X 3 = 48

# Index

## A



## B



## C



## D



## E



## F



## G



## H

# Warranty and Field Service Policy

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products which are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

## Laser Product Warranty

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

## Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

## Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warrantied defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an air freight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

## Returned Product Non-Warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

## Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

## On-Site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty- related, then the following policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

## On-Site Non-Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

AEROTECH, Inc., 101 Zeta Drive, Pittsburgh, Pennsylvania 15238

Phone (412) 963-7470 • TWX 710-795-3125 • FAX (412) 963-7459

Addendum 1

# RS-232 and I/O Bus Error Codes

At times, the user may desire to know if an error condition occurs while operating the Unidex 16 from a remote location. There is a provision to report error conditions and other messages that may appear on the status line through RS-232 communication or the I/O bus. This feature is activated using parameter #541.

There are three ways that these messages may be output.

1. The first method is to output the complete ASCII text message as it appears on the status line of the Unidex 16, sending it (through ports A and/or B) via RS-232 . An example is:

   **"error, undefined variable"**

   This could be sent to an RS-232 terminal, which would permit viewing the messages at a remote location. This mode is activated by setting bit 3 of parameter #541 to a 1 to output through port A, and/or bit 2 to output through port B.

2. The second method is a shorthand version of the first. The difference is that only an error code number is transmitted, instead of the entire message text. For example, instead of transmitting "error, undefined variable", the ASCII message will take the form of the code "CODE 08". This may be useful if the message is to be received and interpreted by a host computer so that some action may be taken. This mode is activated by setting bit 1 of parameter #541 to a 1 to output on port A, and/or bit 0 to output on port B.

3. The third method is to output the code number itself in hexadecimal form at address $700 on the I/O channel. The message "error, undefined variable" would then be output as 08 hex. These signal lines may be coupled to some external logic in order to take appropriate action under certain conditions. This mode is activated by setting bit 7 (the leftmost bit) of parameter #541 to a 1.

All of these methods may be used alone or in conjunction with the other two.

The error codes and their definitive messages are as follows:

| | |
|---|---|
| **CODE 00** | error, no feedrate |
| **CODE 01** | error, feedrate exceed limit |
| **CODE 02** | warning, vector feedrate saturated |
| **CODE 03** | warning, low feedrate, set at min. value |
| **CODE 04** | error, memory over filled |
| **CODE 05** | error, missing "," |
| **CODE 06** | error, illegal entry name |
| **CODE 07** | error, illegal variable name |
| **CODE 08** | error, undefined variable |
| **CODE 09** | error, illegal numerical format |
| **CODE 10** | error, illegal mathematics syntax |
| **CODE 11** | error, can't read system variable in ICRC |
| **CODE 12** | error, tool data undefined |
| **CODE 13** | error, illegal format |
| **CODE 14** | error, can't do "CLS", "RPT", "JUMP" in mdi |
| **CODE 15** | error, illegal code sequence |
| **CODE 16** | warning, change / in ICRC might affect result |
| **CODE 17** | error, quantity too big |
| **CODE 18** | error, illegal I/O code |
| **CODE 19** | warning, I/O value is negative |
| **CODE 20** | error, operand is a zero |
| **CODE 21** | error, nested canned cycle |
| **CODE 22** | error, missing center point of circle |
| **CODE 23** | error, ** limit detected, move aborted |
| **CODE 24** | status, Axis go home completed |
| **CODE 25** | warning, AC power fail |
| **CODE 26** | error, moving toward safe-zone # |
| **CODE 27** | warning, Drive fault |
| **CODE 28** | warning, D/A overrun or halt |
| **CODE 29** | error, - X in limit |
| **CODE 30** | error, + X in limit |
| **CODE 31** | error, - Y in limit |
| **CODE 32** | error, + Y in limit |

| | |
|---|---|
| **CODE 33** | error, - Z in limit |
| **CODE 34** | error, + Z in limit |
| **CODE 35** | error, - U in limit |
| **CODE 36** | error, + U in limit |
| **CODE 37** | error, - V in limit |
| **CODE 38** | error, + V in limit |
| **CODE 39** | error, - W in limit |
| **CODE 40** | error, + W in limit |
| **CODE 41** | (for internal use) |
| **CODE 42** | searching for home limit |
| **CODE 43** | found home limit, now moving out |
| **CODE 44** | out of limit, now searching marker |
| **CODE 45** | found marker, now offsetting |
| **CODE 46** | error, invalid MST-funct. or hardware failed |
| **CODE 47** | error, undefined safe zone |
| **CODE 48** | error, run into subroutine without CLS |
| **CODE 49** | warning ! MFO rate too high |
| **CODE 50** | warning ! MSO rate too high |
| **CODE 51** | waiting for MST acknowledge |
| **CODE 52** | warning ! MFO rate = 0 |
| **CODE 53** | warning ! MSO rate = 0 |
| **CODE 54** | /disk format in progress |
| **CODE 55** | warning, AC power fail, single mode |
| **CODE 56** | warning, Drive fault, single mode |
| **CODE 57** | warning, D/A overrun or halt, single mode |
| **CODE 58** | /disk file copy in progress |
| **CODE 59** | waiting for MST acknowledge release |
| **CODE 60** | replace file xxxxxxxxxxxxxxxxxxxxx ? Y or N |
| **CODE 61** | Insert target disk. Overwrites existing files |
| **CODE 62** | Please insert original source disk |
| **CODE 63** | warning ! S-function data required limiting |
| **CODE 64** | warning ! MSO rate too low |
| **CODE 65** | selected axis pair invalid: please correct |
| **CODE 66** | button active: release all buttons |
| **CODE 67** | press button B2 to enter new axis pair |
| **CODE 68** | (for internal use) |
| **CODE 69** | error, DATAFILE .PP already exists |
| **CODE 70** | error, DATAFILE. PP out of memory |
| **CODE 71** | warning, DATAFILE .PP will be deactivated |

| | |
|---|---|
| **CODE 72** | error, DATAFILE .PP is inhibited, cannot run |
| **CODE 73** | error, merge buffer information is not valid |
| **CODE 74** | error, quantity too small |
| **CODE 75** | error, quantity negative or zero |
| **CODE 76** | error, undefined subroutine or entry point |
| **CODE 77** | error, undefined variable, JUMP or CLS name |

**NOTE:** Numbers 78 to 100 are not used at this time.

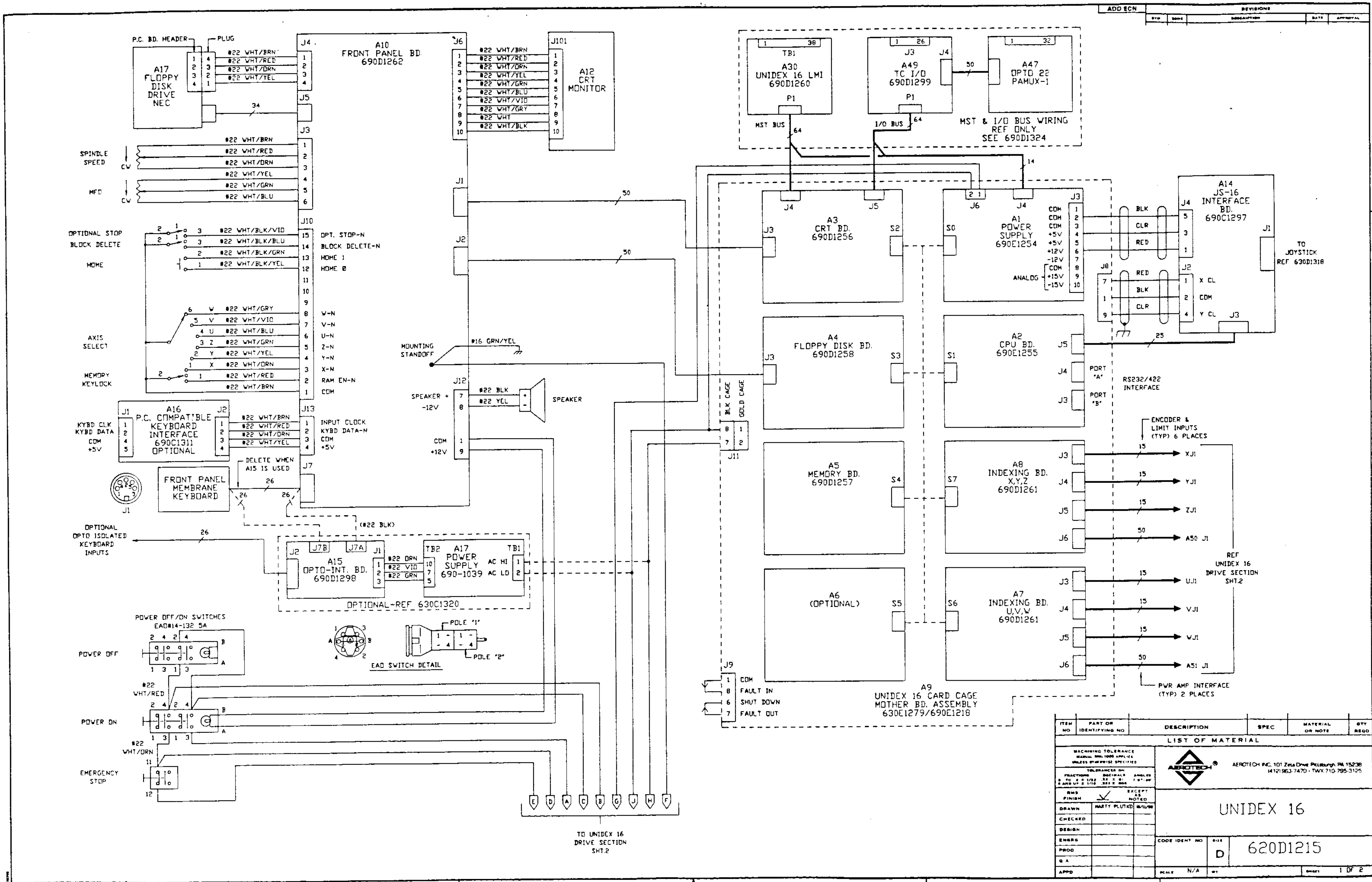
| | |
|---|---|
| **CODE 101** | cycle start |
| **CODE 102** | shift cycle start |
| **CODE 103** | MSG dwell cleared by cycle start |
| **CODE 104** | system reset |
| **CODE 105** | MFO updated |
| **CODE 106** | MSO updated |
| **CODE 107** | feedhold off |
| **CODE 108** | feedhold on |

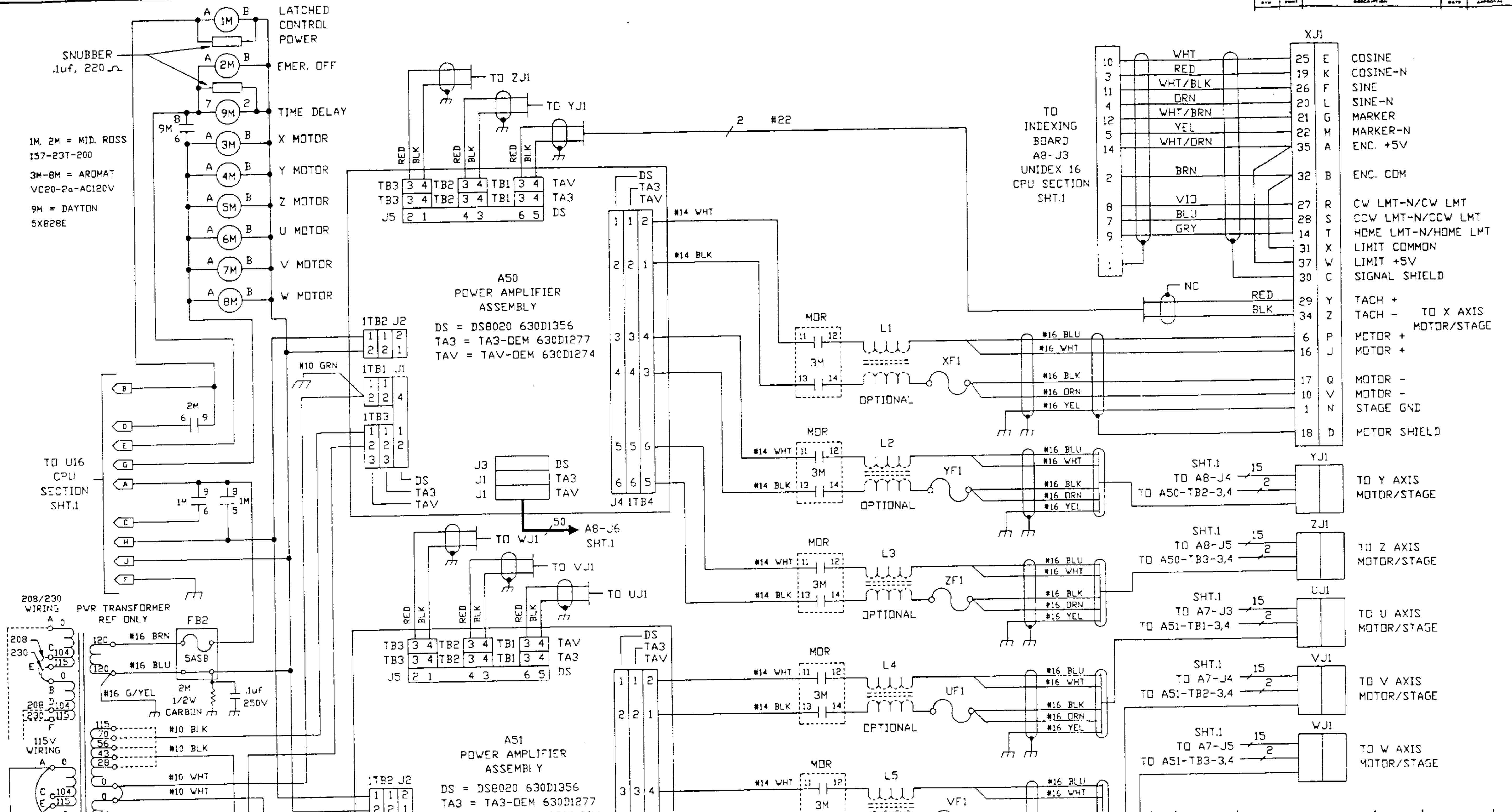
| | |
|---|---|
| **CODE 151** | battery ok |
| **CODE 152** | battery bad |
| **CODE 153** | ram ok |
| **CODE 154** | ram bad |
| **CODE 155** | rom ok |
| **CODE 156** | rom bad |
| **CODE 157** | eeprom ok |
| **CODE 158** | eeprom bad |
| **CODE 159** | user ram bad |
| **CODE 160** | checksum error |
| **CODE 161** | all user ram clear |

## Addendum 2

# Generic System Drawings

*(For specific details, see the system drawings supplied with your system)*


P.C. BD. HEADER
PLUG
A17 FLOPPY DISK DRIVE NEC
A10 FRONT PANEL BD 690D1262
A12 CRT MONITOR
SPINDLE SPEED
MFO
OPTIONAL STOP
BLOCK DELETE
HOME
AXIS SELECT
MEMORY KEYLOCK
OPT. STOP-N
BLOCK DELETE-N
HOME 1
HOME 0
RAM EN-N
COM
A16 P.C. COMPATIBLE KEYBOARD INTERFACE 690C1311 OPTIONAL
KYBD CLK
KYBD DATA
INPUT CLOCK
KYBD DATA-N
FRONT PANEL MEMBRANE KEYBOARD
DELETE WHEN A15 IS USED
MOUNTING STANDOFF
#16 GRN/YEL
SPEAKER
OPTIONAL OPTO ISOLATED KEYBOARD INPUTS
A15 OPTO-INT. BD. 690D1298
A17 POWER SUPPLY 690-1039
AC HI
AC LO
OPTIONAL-REF 630C1320
POWER OFF/ON SWITCHES EAO#14-132 5A
POWER OFF
POWER ON
EMERGENCY STOP
EAO SWITCH DETAIL
POLE "1"
POLE "2"
TO UNIDEX 16 DRIVE SECTION SHT.2
A30 UNIDEX 16 LMI 690D1260
A49 TC I/O 690D1299
A47 OPTO 22 PAMUX-1
MST BUS
I/O BUS
MST & I/O BUS WIRING REF ONLY SEE 690D1324
A3 CRT BD. 690D1256
A1 POWER SUPPLY 690E1254
ANALOG
A4 FLOPPY DISK BD. 690D1258
A2 CPU BD. 690E1255
PORT "A"
PORT "B"
RS232/422 INTERFACE
A5 MEMORY BD. 690D1257
A8 INDEXING BD. X,Y,Z 690D1261
A6 (OPTIONAL)
A7 INDEXING BD. U,V,W 690D1261
BLK CAGE
GOLD CAGE
COM
FAULT IN
SHUT DOWN
FAULT OUT
A9 UNIDEX 16 CARD CAGE MOTHER BD. ASSEMBLY 630E1279/690E1218
A14 JS-16 INTERFACE BD. 690C1297
X CL
Y CL
TO JOYSTICK REF 630D1318
ENCODER & LIMIT INPUTS (TYP) 6 PLACES
PWR AMP INTERFACE (TYP) 2 PLACES
REF UNIDEX 16 DRIVE SECTION SHT.2
LIST OF MATERIAL
AEROTECH
AEROTECH INC. 101 Zeta Drive Pittsburgh PA 15238
UNIDEX 16
620D1215
1 OF 2




| ITEM NO | PART OR IDENTIFYING NO | DESCRIPTION | SPEC | MATERIAL OR NOTE | QTY REQD |
|---|---|---|---|---|---|

LIST OF MATERIAL

AEROTECH INC. 101 Zeta Drive Pittsburgh PA 15238 (412) 963-7470 · TWX 710-795-3125

DRAWN MARTY PLUTKO

UNIDEX 16

SIZE D 620D1215

SCALE N/A

SHEET 2 OF 2