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AEROTECH, INC.

UNIDEX II, MANUAL

Rev. C - 6A

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1.0 INTRODUCTION

Unidex II is an advanced, two-axis, point-to-point, microprocessor controlled positioning system capable of interfacing with any of Aerotech's encoded D.C. motor drives or stepping motor drives. It provides for up to six digits of position command and four digits of feedrate with a range from 10 steps/second to 50,000 steps/second. Other features include:

- Home
- Home Offset
- Manual Run and Step
- Absolute/Incremental Indexing
- M Function Outputs

Additionally, Unidex II can operate in either one of two modes - Local or Remote. In Local Mode, commands are entered and executed via a 16-key front panel keypad. In the Remote Mode, command entry and execution are controlled by an external computer communicating with Unidex II over an IEEE-488 Bus. Use of the IEEE-488 Bus greatly simplifies the Remote interface and makes it as simple as plugging the devices together.

1.1 HOW TO USE THIS MANUAL

This manual applies to REV. C and later models of Unidex II and Software Version 6A*. While enhancements are being made to improve the performance of the newer Unidex II models, it should be noted that the new versions are downward compatible with the older models.

* The revision number and software version number are indicated as shown in Figure 2.1.

manual should be thoroughly read and understood. There are six chapters in this manual and each one is designed to provide a specific type of information to the user.

Chapter 1 - Provides an introduction to the capabilities of the Unidex II System and outlines the contents of each chapter.

Chapter 2 - Provides information on installation and configuration of the system.

Chapter 3 - Outlines the use of the front panel for entering and executing commands. Explains the function of all of the keys.

Chapter 4 - This chapter covers all information relating to the use of the Remote interface.

Chapter 5 - Explains the meaning and use of all commands which Unidex II is capable of executing.

Chapter 6 - Provides error messages.

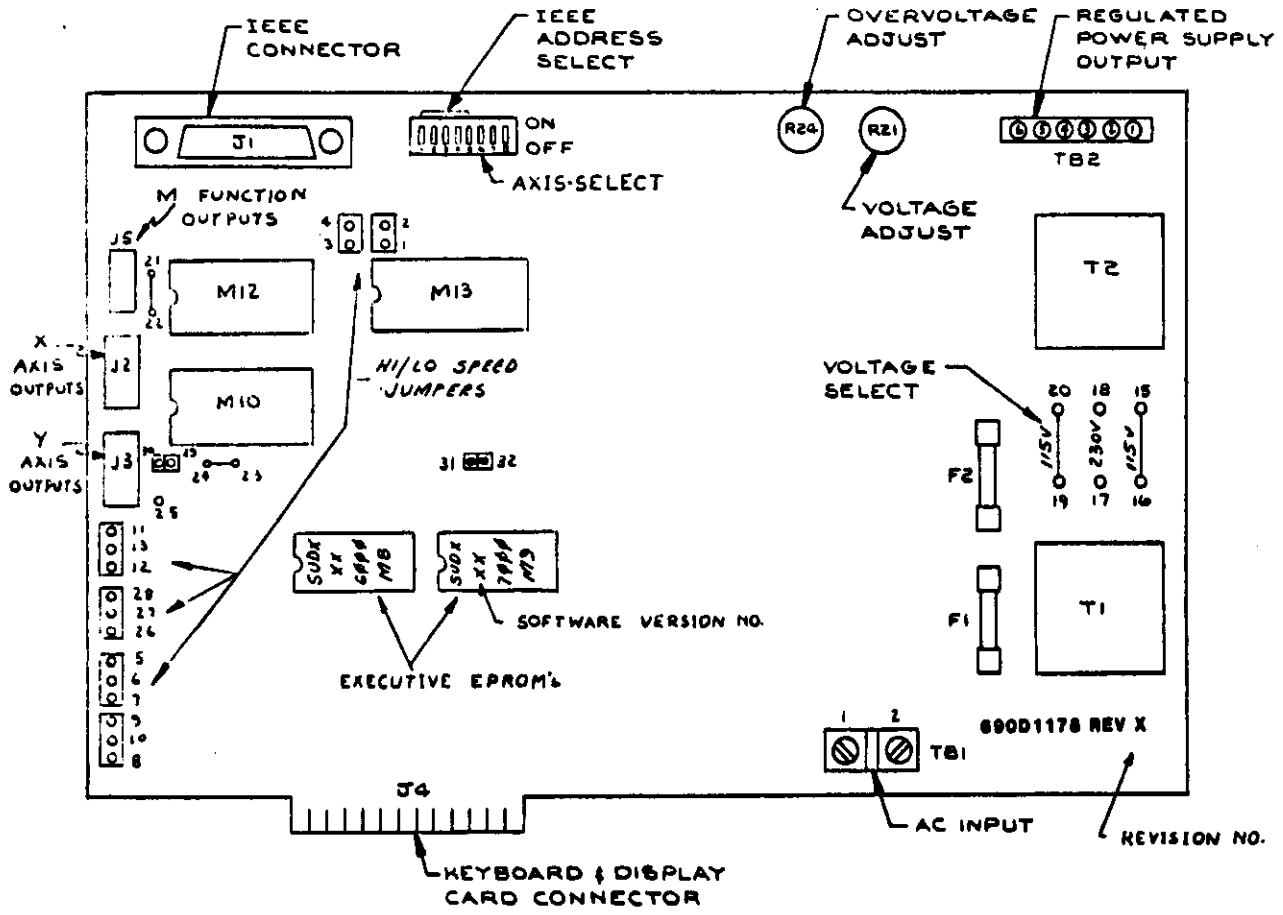
IEEE CONNECTOR
IEEE ADDRESS SELECT
OVERVOLTAGE ADJUST
REGULATED POWER SUPPLY OUTPUT
J1
ON
OFF
AXIS-SELECT
R24
R21
TB2
VOLTAGE ADJUST
M FUNCTION OUTPUTS
J5
M12
M13
T2
X AXIS OUTPUTS
J2
M10
HI/LO SPEED JUMPERS
VOLTAGE SELECT
Y AXIS OUTPUTS
J3
F2
F1
T1
SOFTWARE VERSION NO.
EXECUTIVE EPROM's
690D1178 REV X
TB1
J4
AC INPUT
REVISION NO.
KEYBOARD & DISPLAY CARD CONNECTOR

Figure 2.1

2.0 INSTALLATION INSTRUCTIONS

This section describes all power and signal inputs and outputs, jumpers, and switch settings on the Unidex II microprocessor board (refer to Figure 2.1). While most settings will be configured at the factory, it is important to understand the function of all jumpers and connectors should any problems arise.

2.1 UNPACKING

Unpack the System from its shipping container and referring to the sales order, verify that all items are present. Save the packing material for storing and reshipping the System. If the shipping container is damaged upon receipt, request that the carrier's agent be present while the System is being unpacked and inspected.

2.2 INSPECTION

The System should be inspected upon receipt for broken, damaged or loosened parts. Retighten any loosened connectors.

2.3 INSTALLATION

Install all motor connectors and cables before applying power to the System. If the System includes an Aerotech stage, refer to the stage manual and remove shipping clips. If the system does not include a stage, the drives will have to be adjusted for proper response to the load inertia and friction; refer to the drive manuals for adjustment procedures.

2.4 A.C. POWER REQUIREMENTS

The standard System requires 115/230VAC $\pm$10% at 50-60Hz. Unidex II itself requires .5A at 115VAC, however, in a typical system composed of a Unidex II, two 4020 amplifiers, two SL Cards and two

encoders, the chassis will be fused at 5 Amps. It is predominantly the power amplifier which will determine the system power requirements.

2.5 115/230VAC OPERATION

Unidex II is capable of operating on either 115VAC or 230VAC. Table 2.5.1 illustrates the jumper connections required for operating voltage selection.

A.C. Voltage	Add Jumpers	Remove Jumpers
115	15-16 19-20	17-18
230	17-18	15-16 19-20

Table 2.5.1 - 115/230VAC Jumpers

2.6 REGULATED POWER SUPPLY OUTPUT

The regulated voltages from the Unidex II power supplies are made available to TB2 (refer to Figure 2.1). Tables 2.6.1 and 2.6.2 illustrate the voltages and currents available from DC and lo speed stepper motor systems respectively.

TB2 Pin #	1	2	3 4	5 6
Output Voltage	+12	-12	+5	Gnd
Output Current	200mA	200mA	250mA	---

Table 2.6.1 - D.C. System

TB2 Pin #	1	2	3 4	5 6
Output Voltage	+12	-12	+5	Gnd
Output Current	200mA	200mA	500mA	---

Table 2.6.2 - Stepper Systems

2.7 SYSTEM JUMPER CONFIGURATION

Unidex II can operate with (i) DC-SL, (ii) hi speed stepper motor systems* or (iii) lo speed stepper motor systems. The last option can be with Home Limit only or with Home Limit and Marker. The type of drive is set by selecting the proper combination of jumpers as is shown in Table 2.7.1.

Jumpers / System Type	1-2	3-4	5-6-7	8-9-10	11-12-13	26-27-28
High Speed Stepper*	IN	IN	6-7	9-10	11-13	27-28
D.C. System	OUT	IN	6-7	9-10	11-13	27-28
Low Speed Stepper With Home Limit & Marker	IN	OUT	5-6	8-10	12-13	26-27
Low Speed Stepper With Home Limit Only	OUT	OUT	5-6	9-10	12-13	27-28
Low Speed Stepper With Home Card	IN	IN	5-6	9-10	12-13	27-28

Table 2.7.1 - Jumper Configuration

* A high speed stepper is defined here as one that uses Aerotech's 10KR Ramping Board or its equivalent to interface to Unidex II.

Switch 1, position 6 defines the number of axes used in a Unidex II system. If both axes are used, it should be in OFF position; if only X axis is used, then it should be ON. This function has not been implemented in Version 6A Software.

Jumper 29-30 has been provided for future enhancement. Jumper 31-32 is IN.

2.8 M FUNCTION OUTPUT CONNECTIONS

There are four output lines and one input line dedicated to the M Function operations. Figure 2.1 shows the placement of the M Function connector (J5) on the microprocessor board and Table 2.8.1 shows the correspondence between pin numbers and signals. These lines exit the board directly from a Peripheral Interface Adapter (PIA) and are capable of driving one standard TTL load. Care should be exercised when using these lines since they are unbuffered.

J5 Pin #	Function
1	Output #1
2	Output #2
3	Output #3
4	Output #4
5	$\overline{\text{Continue}}$ Input
6	Logic Ground

Table 2.8.1 - M Function Outputs

2.9 X/Y AXIS OUTPUT CONNECTIONS

Connectors J2 and J3 are the axis outputs for the X axis and Y axis respectively (refer to Figure 2.1). The functions signal of the lines are identical for both axes and are shown in Table 2.9.1 below.

J2/J3 Pin #	D.C. & Hi Speed Stepper System	Low Speed Stepper With Home Card	Low Speed Stepper Without Home Card
1	+5	+5	+5
2	Gnd.	Gnd.	Gnd.
3	Clock	Clock	Clock
4	Direction	Direction	Direction
5	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$
6	Key	Key	Key
7	Count Zero	Low-Hi	Low-Hi
8	$\overline{\text{LIMIT}}$	$\overline{\text{LIMIT}}$	$\overline{\text{LIMIT}}$
9	$\overline{\text{GO HOME}}$	$\overline{\text{GO HOME}}$	Marker
10	AT HOME	AT HOME	$\overline{\text{HOME LMT}}$

Table 2.9.1 - Pin Definition On J2 And J3

2.10 IEEE-488 OUTPUT

Unidex II is provided with an IEEE-488 interface connector at the back of the chassis.

2.11 IEEE-488 ADDRESS SELECTION

Selection of Unidex II's IEEE-488 device address is accomplished by using switches 1 through 5 of SW1 (refer to Figure 2.1). Appendix A lists all possible address combinations.

2.12 SYSTEM POWER-UP

On power-up, Unidex II will reset both drives, initialize itself, and perform a self-test. The displays will be lit for a period of five seconds to enable the operator to detect inoperative display segments. Next, the message CPU UP or an error message will be displayed based on the results of the self-test. If the test fails, the system should be serviced. If Unidex II passed the self-test, the CPU UP message will appear along with the LCL and RMT LED's and Unidex II will be ready to accept commands. At this point, the system will be set to the following default conditions:

- Local Mode With Remote Enabled
- Incremental Mode - G91
- Non-Corner Rounding Mode - G24
- Display Enable Mode - G61

3.0 FRONT PANEL OPERATION

Front Panel Operation is possible only when Unidex II is in the Local Mode, that is, the remote IEEE-488 interface is not active. This is indicated by the LCL LED being lit and RMT LED being not hit. In addition to being able to enter and execute commands from the front panel, the drives can be positioned manually using the Step and Slew Functions. A description of all Front Panel Functions follows (refer to Figure 3.1 for keyboard operations).

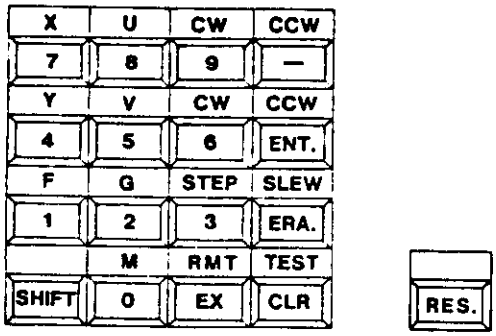

Figure 3.1

3.1 RESET

Pressing the RES key causes the system operation to be halted regardless of the command currently being executed. Both drives will be stopped (if in motion) and reset. The system will then be initialized and the ERROR 2 message will be displayed. If Unidex II was in the Remote Mode, it will return to Local Mode after pressing RES.

3.2 TEST

The Test Function provides a means of testing Unidex II without destroying the contents of the absolute position registers. Pressing the key sequence:

SHIFT TEST

will cause the system to perform a self-test and light the displays with 8's for five seconds. If the system test was performed satisfactorily, then the message CPU UP will be displayed. If an error occurs during the self-test, the message 99 or 98 will be displayed.

3.3 MANUAL OPERATION

Manual operation allows the operator to manually position the drives using the front panel keyboard; only one drive may be stepped or slewed at a time. Figure 3.3.1 shows the keys active in the Manual Mode. There are two modes of manual operation, Manual Step and Manual Slew. Once the Step or Slew Mode has been entered, the top row CW and CCW keys control the X axis and the second from the top row CW and CCW keys control the Y axis.

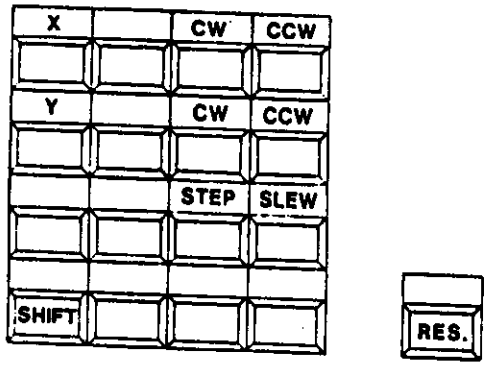

Figure 3.3.1

3.3.1 STEP

The Step Function is useful for precise positioning of the drives. It causes the drive to move one step each time the CW or CCW key is depressed. To enter the Step Mode, the following key sequence should be entered:

SHIFT STEP

The MAN LED will now light, indicating that Unidex II has entered the Manual Mode. At this point, pressing any X or Y CW or CCW keys will cause the appropriate drive to move one step. Pressing any key other than one of the direction keys will cause Unidex II to exit the Manual Mode.

3.3.2 SLEW

The Slew Function is useful for rapid positioning of the drives manually. Once this mode is entered, pressing and holding the CW or CCW key will cause the selected drive to move in the desired direction until the key is released. The feedrate at which the drives move is dictated by the programmed feedrate. This relationship between programmed feedrate and the actual slew rate is shown in Table 3.3.2.1. It should be noted that at the higher feedrates, the drives will move in increments of 10, 100 or 1000 steps depending on the feedrate entered.

Programmed Feedrate	Slew Feedrate (Steps/Second)	Increment Size # Of Steps
1-9	10-90	1
10-99	100-990	10
100-999	1,000-9,990	100
1,000-5,000	10,000-50,000	1000

Table 3.3.2.1 - Manual Mode Stepping Increments

As in the Step Mode, pressing any key other than a direction key will cause Unidex II to exit the Manual Mode.

3.4 ENTER

The ENT key is used to enter a command into Unidex II for later execution. It is important to recognize that a command cannot be executed unless it has first been entered.

3.5 X/Y COMMAND ENTRY

In entering X or Y positioning commands, the following key sequences should be used:

X Command: SHIFT X (Up to 6 digits) ENT

Y Command: SHIFT Y (Up to 6 digits) ENT

As the digits are entered, they will be displayed on the X axis digit display for an X Command and on the Y axis digit display for a Y Command. Once the command has been entered (using the ENT key), it will replace the corresponding old command in the Unidex II's memory.

3.6 X HOME OFFSET-"U"/Y HOME OFFSET-"V" COMMAND ENTRY

Entering an X or Y Home Offset Command is similar to entering an X or Y movement command. The one exception is that the U or V keys are used in place of the X or Y keys. The U key in the top row is used to enter an X Home Offset and the V key in the second from the top row is used to enter the Y Home Offsets.

Some examples follow:

X HOME OFFSET: SHIFT U (Up to 6 digits) ENT

Y HOME OFFSET: SHIFT V (Up to 6 digits) ENT

As with the movement commands, the X Home Offset will appear in the X display and the Y Home Offset will appear in the Y display.

3.7 ERASE

The ERA key is used to delete a command currently being loaded into the display but which has not yet been entered. After pressing

ERA, the function that was being entered will be deleted and Unidex II will be ready to accept a new command.

3.8 CLEAR

The CLR key is used to delete a command that has been previously entered into Unidex II. The procedure for clearing X, Y, U, V, and F Commands requires only the general function to be specified as illustrated below:

Clear X Command: CLR SHIFT X ENT

Clear V Command: CLR SHIFT V ENT

Clear F Command: CLR SHIFT F ENT

When clearing G and M Commands, the operator must specify the exact command as can be seen by the examples below:

Clear G91 Command: CLR SHIFT G 9 1 ENT

Clear M32 Command: CLR SHIFT M 3 2 ENT

Upon pressing the ENT key, the specified command will be deleted and the message CLEAR will be displayed for two seconds.

3.9 EXECUTE

Pressing the EX key will cause Unidex II to begin execution of all commands previously entered. Please refer to Section 4.4 on command details. It is important to note that (with the exception of certain non-modal G Commands, e.g., G7) repeated pressing of the EX key will cause that block of commands currently in Unidex II to be repeatedly executed.

3.10 REMOTE

When Unidex II is in the LOCAL Mode, the key sequence SHIFT RMT will cause the Remote Interface to be enabled. This will cause the RMT LED to go ON indicating that Unidex II is now in LOCAL Mode with REMOTE enabled. When the controller takes control, the LCL LED goes

off indicating that the Remote Mode has been entered and the keyboard (with the exception of the RES key which will cause Unidex II to enter the Local Mode) will be deactivated until the remote controller returns Unidex II to the Local Mode. Refer to Section 4.0 for more detailed information on Remote Operation.

4.0 REMOTE OPERATION WITH THE IEEE-488

When it is not desirable to operate Unidex II manually or several Unidex II's must be operated simultaneously, the Remote Interface can be used. The Remote Interface consists of a talker/listener implementation of the IEEE-488-1978 standard bus (also referred to as HPIB and GPIB). The remote bus allows up to 14 Unidex II's (or any other IEEE-488 compatible device) to communicate with a computer used as the bus controller.

4.1 ADDRESSING

Each device connected to the Remote Interface must have its own unique bus address. On Unidex II, switches 1 through 5 of SW1 (refer to Figure 2.1) are used to select the specific device address. These switches are encoded in binary fashion with Switch 1 representing the least significant bit (LSB) and Switch 5 representing the most significant bit (MSB). Appendix A lists all possible address combinations. It is the users responsibility to configure the address of each Unidex II in his particular system.

4.2 INTERCONNECTION

One of the primary advantages of the IEEE-488 bus is that there is no need for special wiring to adapt the device's interface to another. Connecting devices on the IEEE-488 bus is as simple as pluging the units together using a standard bus cable (refer to Appendix B for a list of manufacturers of IEEE-488 cables) and selecting their addresses.

4.2.1 NUMBER OF DEVICES

Up to 14 devices plus the controller can be connected to the bus at one time. These 14 devices can be any combination of talker,

listener or talker-listener. However, there can never be more than one talker or one active controller on the bus at one time.

4.2.2 CABLE RESTRICTIONS

Due to the nature of the bus, there are certain cabling restrictions which should be observed when interconnecting devices on the bus. The maximum length of cable that can be used to connect a group of devices within one bus system is:

1. 2 meters times the number of devices
2. or, 20 meters, whichever is less

This maximum length of cable defined above may be distributed among the devices in the system in any manner deemed suitable by the user. The minimum handshake time for all devices on the bus is 4 micro-seconds.

4.3 REMOTE ENABLING AND CONTROL

When power is initially applied, Unidex II enters the Local Mode with Remote enabled. This is indicated by the LCL LED and RMT LED being lit; at this point, the Remote Interface is enabled and Unidex II is ready to accept commands from either the front panel controls or the Remote controller.

The source of the next command will now determine the mode that Unidex II will enter. If a key is depressed on the front panel, Unidex II will disable the Remote Interface enter the Local Mode and will respond only to the front panel. However, if the REN line of the IEEE-488 bus is asserted as a result of any bus activity, the LCL LED would go out leaving only RMT LED on, indicating that Unidex II has entered the Remote Mode and will only respond to commands from the remote bus controller. Once Unidex II has entered the Remote Mode, the

front panel is disabled, with the exception of the RES key. This key will always reset the system and put Unidex II into Local Mode whenever it is pressed. If the remote bus controller completes its operation, it may command Unidex II to return to Local Mode or clear the Unidex II to power-up state. When this occurs, the LCL LED will light and Unidex II will enter the Local Mode with the Remote Interface still enabled. Again, the next command Unidex II receives will determine which mode, Local or Remote, that it enters. To summarize, when the LCL LED is on with RMT LED off, the operator may control Unidex II via the front panel and when the LCL LED is off with RMT LED on, the front panel is deactivated and the remote bus controller controls Unidex II.

4.4 COMMAND FORMATS

Unidex II adheres to a subset of the EIA RS-274-D standard for formating messages sent over the IEEE-488 bus. Additionally, individual characters will be coded in ASCII.

4.4.1 COMMAND CHARACTER SET

Appendix C contains a list of characters which Unidex II will accept, their HEX-ASCII codes, and their functions. Appendix E lists the IEEE-488 bus interface functions and Unidex II responses.

4.4.2 ORDER OF ENTRY

Commands sent over the Remote Interface should adhere to the order specified by the EIA RS-274 standard. This sequence is as follows:

1. Preparatory (G) Commands
2. Axis Commands (X), (Y)
3. Feedrate (F) Commands
4. Miscellaneous (M) Commands
5. End of Block Indication

To send a command, the user must send the letter character identifying the command (refer to Appendix C) and the actual command code (digits). On earlier versions of Unidex II, a "," (comma) was required to be sent following each command. The newer versions do not require this comma, but will accept it in order to retain compatibility with the earlier versions.

Example: To send an M32 Command, an F1000 Command and an X1250 Command the following character sequence should be sent:

Character												
X	1	2	5	0	F	1	0	0	0	M	3	2
58	31	32	35	30	46	31	30	30	30	4D	33	32
ASCII (HEX)												

4.4.3 END OF BLOCK

Each block of commands sent to Unidex II must be followed by an "End of Block" indicator. There are two ways of doing this.

The first method involves sending the character sequence CR LF (carriage return, line feed) after all commands in the block have been sent. This will signal to Unidex II that the complete block has been transmitted. Execution of the block will begin immediately unless the Trigger Mode is in effect.

Example: Send F100 and X2000 Commands.

Terminate With CR LF:

Character										
X	2	0	0	0	F	1	0	0	CR	LF
50	32	30	30	30	46	31	30	30	0D	0A
ASCII										

The second method involves setting the End Or Identify (EOI, refer to documentation for your IEEE-488 Controller) line low as the last byte in the command block is sent. In this case execution will begin as soon as the last command has been processed.

Example: Send F100 and X2000 Commands.

Terminate With EOI:

Character									
X	2	0	0	0	F	1	0	0	
50	32	30	30	30	46	31	30	30	EOI set low during transmission of last byte.

ASCII

The following are permitted as END OF BLOCK sequences:

CR LF ; LF ; EOI ; CR(EOI) ; LF(EOI) ; CR LF(EOI) ; CR CR . . CR(EOI)

If a character is sent after an END OF BLOCK sequence, the bus is hung up. Unidex II starts execution upon receiving a valid END OF BLOCK and does not accept the extra character. The Remote Controller waits for the data to be accepted; Unidex II waits for a serial poll.

4.4.4 TRIGGER MODE

If several Unidex II's must be synchronized to begin execution together, the Group Execute Trigger (GET) Command can be used to hold off immediate execution. This function is signified by the "H" character. When this character is appended to the command block, it prevents Unidex II from beginning execution of the block until the remote bus Controller sends the "GET" or "TRIGGER" Command.

Example: Send F100 and X1000 with Trigger hold off.

Send: X100 F100 H CR LF

Now the commands are entered, but execution has been delayed.

Send: "TRIGGER" Command (Refer to documentation for your IEEE-488 Controller.)

Execution begins at this point

4.4.5 REMOTE COMMAND CLEAR

In the Remote Mode the letter "D" does the clear function. However, the message "CLEAR" is not displayed on the front panel. A Clear Command is treated just like any other command and as a signal to indicate the completion of a command, SRQ is asserted. A command block containing a Clear Command is not executed. If there are other executable commands in the same block, they are entered but not executed.

Example:

1. X100 Y100 F100 (CRLF)	Executes the command block and asserts SRQ
2. (Serial Poll)	Clears X Command and asserts SRQ.
DX Y5000 (CRLF)	Y5000 is entered.
3. (Serial Poll) (CRLF)	Executes Y5000 F100 and asserts SRQ.

Commands may also be cleared when Unidex II is in the Trigger Mode.

The Clear Command "DH" may be used to clear the H Function. Once again, Unidex II does not execute on a Clear Command.

4.4.6 STATUS AND REMOTE PROGRAMMING OF UNIDEX II

The internal status of Unidex II is available to the remote controller at all times by performing a Serial Poll. Unidex II returns a data byte to the controller that is the Status Byte. The 8 bits of the Status Byte may be interpretted as follows:

	Bit Value 0 (Cleared)	Bit Value 1 (Set)
Bit 0	Not busy executing a Motion Command	Busy executing a Motion Command
Bit 1	Command execution not complete	Command execution complete
Bit 2	Remote Mote	Local Mode
Bit 3	Non-Corner Rounding Mode	Corner Rounding Mode
Bit 4	Absolute Mode	Incremental Mode
Bit 5	Remote not enabled	Remote enabled
Bit 6	SRQ not asserted	SRQ asserted
Bit 7	No error	Error has occurred

Bit 1 is set when Unidex II has completed dealing with the command block and has asserted SRQ. This bit is set even if the motion cannot be executed due to an error or if the command is a non-motion command such as the Clear Command "DX". Once set, Bit 1 is cleared when a new command is entered.

Bit 7 is set when an error condition is detected. An error may be generated due to an invalid motion command or due to the Limit Switch being activated. An invalid Motion Command renders the command block unexecutable. Even though the error is detected during the entry of the command, the entire command block is received by Unidex II without causing a bus-hang-up. When the End Of Block is received, Unidex II sets the status byte appropriately and asserts SRQ. The detected errors are noted and the corresponding bits of the Error Status Byte

are set (refer to Section 4.4.8 for reading and interpretting the Error Status Byte).

A limit error interrupts Unidex II and places it in the Local Mode. Bit 7 and Bit 2 of the status byte are set. Section 4.5 describes the handling of a limit situation.

Bit 6 is set to assert the SRQ line on the IEEE-488 bus causing a service request to the controller. The SRQ line is asserted to indicate to the controller that Unidex II has completely dealt with the command block and is waiting for a serial poll. The Controller should subsequently conduct a serial poll to determine the status of the device requesting service. Until the Controller performs a serial poll on the Unidex II currently requesting service, it will "hang up" waiting for the serial poll. Until the poll (which automatically clears the SRQ), the Unidex II in question will accept no further commands including Group Execute Trigger. You may wish to configure your Controller so that it responds to SRQ via an interrupt. To minimize the time lost between moves, the careful Controller programmer will:

1. Build up the next command while Unidex II is executing the current command.
2. Respond to SRQ via an Interrupt Service Routine (ISR) that:
   a. Polls the active Unidex II's.
   b. Clears any Controller registers that need to be reset.
3. Transmits the next command on return from the ISR (or as last item in ISR).

Unless these or similar procedures are followed, the Corner Rounding Mode (G23, refer to Section 5.2.3) will prove ineffectual,

due to time wasted in inefficient protocol. Efficient protocols are easily implemented on generally available IEEE-488 Controllers. When using an interpreter-type language (e.g., BASIC) on a slower microprocessor-type Controller (e.g., personal computer) it is also helpful to get as much code as is feasible and logical on a single line.

4.4.7 REQUESTING STATUS AND POSITION FROM UNIDEX II

The remote controller may request position and status information when Unidex II is in the Remote Mode and is not busy. This is done by causing Unidex II to enter the Talker Mode. The information transmitted to the remote controller is sent in the following order and format:

1.	Status Byte	Binary Value
2.	CR/LF	Carriage return and line feed characters in ASCII code
3.	X Absolute Position	Six digits plus minus sign if negative, in ASCII code; leading zeros are sent
4.	CR/LF	<CR> <LF> in ASCII code
5.	Y Absolute Position	Same as for X Position
6.	CR/LF with EOI	<CL> <LF> in ASCII code; EOI concurrent with <LF>

Example: Suppose Unidex II is at the following position:

X = 1000

Y = -2750

If the controller requests position and status information, the following will be sent:

<Status> CR LF 0 0 1 0 0 0 CR LF - 0 0 2 7 5 0 CR LF (+EOI)

The status sent by Unidex II when requested can be one of two statuses. When no error condition exists and Bit 7 of the Serial Poll Status Byte (status returned upon serial polling Unidex II) is clear, Unidex II upon entering Talker Mode, sends the normal status byte which is the same as the Serial Poll Status Byte.

If the Serial Poll Status Byte shows an error (Bit 7 is set) and Unidex II is requested for information, the status byte sent by Unidex II is the ERROR STATUS. The bits of the Error Status Byte may be decoded to determine what caused the error condition as explained in the next section.

4.4.8 ERROR STATUS BYTE

When an error condition exists and the Bit 7 of the Serial Poll Status Byte is set, the cause for the error may be determined by requesting Unidex II for information and decoding the Error Status Byte sent by Unidex II. The Error Status Byte is the first byte of the entire information package as described in the previous section.

The 8 bits of the Error Status Byte may be interpretted as follows:

	Bit Value 0 (Cleared)	Bit Value 1 (Set)	Corresponding Error Codes In Local Mode
Bit 0		For future use	
Bit 1	No number error	Number entered without command being active	Error 09
Bit 2	No M Error	Invalid M Command	Error 06 or Error 07
Bit 3	No F Error	Invalid or missing feedrate	Error 04 or Error 11
Bit 4	No G Error	Invalid G Command	Error 05
Bit 5	No Y-Limit Error	Y-Axis Limit activiated	Error 01
Bit 6	No X-Limit Error	X-Axis Limit activated	Error 01
Bit 7	Bit 7 is SET to indicate that the status being read is the Error Status. CLEAR indicates normal status and Bit 0 through Bit 6 represents System Status as in Section 4.4.6.		

4.5 ERROR HANDLING

It is possible to detect and correct invalid motion commands before the erroneous command block executes. When Unidex II detects an invalid motion command, the corresponding bit in the Error Status Byte is set. Even though the error is detected during entry, Unidex II receives the entire command block from the remote controller without causing a bus-hang-up. When the End Of Block is received, Unidex II, having detected the error, sets Bit 7 of the Serial Poll Status Byte and assets the SRQ line before execution.

Having done a serial poll of Unidex II and seeing the error bit of the Serial Poll Byte set, if the remote controller now wishes to determine the cause of the error, Unidex II may be requested to send information. The first byte sent by Unidex II is the Error Status Byte.

4.6 RESETING THE SYSTEM

If the Reset key, which is the only active key when in Remote Mode, is pressed, Unidex II will return to Local Mode with the Remote Interface disabled. This will be reflected in the Serial Poll Status Byte the user should provide some means of detecting this and alerting the operator.

5.0 COMMAND PROGRAMMING

5.1 X AND Y MOVEMENT

The X and Y axis can be programmed to move over a range of from 1 to 999,999 steps in either a clockwise or counter-clockwise direction.

5.2 PREPARATORY CODES

The preparatory codes consist of functions which configure the system environment prior to axis movement. The preparatory commands are termed Modal or Non-Modal, depending upon whether they remain in effect until reset (Modal) or are 'self-resetting" (Non-Modal). The Modal Commands are identifiable by the fact that they are defined in pairs. When a Modal Command is given, it automatically resets the command paired with it. One of the two commands in a modal pair is the default command; it is set into effect on power-up and whenever the RESET key is depressed.

5.2.1 ABSOLUTE/INCREMENTAL PROGRAMMING - G90/G91 (MODAL)

5.2.1.1 ABSOLUTE PROGRAMMING - G90 (PAIRED WITH G91)

A G90 Command places Unidex II in the Absolute Programming Mode so that all axis commands are executed with respect to the position stored in the Absolute Position Registers. Once an absolute move has been executed, a new Absolute Axis Command must be entered to cause further movement. Absolute Positioning Commands must never exceed an incremental index of 999,999 steps. For example, if the absolute position is +600,000, a command to move to position -600,000 is not allowed because it would require an incremental index of -1,200,000 steps which exceeds the 999,999 limitation. Once executed, G90 remains in effect until cancelled by G91.

5.2.1.2 INCREMENTAL PROGRAMMING - G91 (PAIRED WITH G90)

A G91 Command places Unidex II in the Incremental Programming Mode. When in this Mode, all axis commands will be made with respect to the present position. For example, execution of the command X1000 in the Incremental Mode will cause the motor to take 1000 steps in the CW direction, regardless of its present position. This mode is entered at power-up by default. When executed, G91 remains in effect until cancelled by G90.

5.2.2 DISPLAY DISABLE/ENABLE - G60/G61 (MODAL PAIR)

By using the G60/G61 Command Pair, the operator can disable or enable the displays when data is being received in the Remote Mode. The ability to disable the displays on data input allows faster operation on the IEEE-488 Interface, while the ability to enable the displays during data input allows the operator to observe the data as it is received by Unidex II. The G61 Mode is entered by default at power-up (i.e., the display is enabled) and remains in effect until cancelled by a G60 Command.

5.2.3 CORNER ROUNDING/NON-CORNER ROUNDING - G23/G24 (MODAL PAIR)

Corner Rounding or Non-Corner Rounding is selected by codes G23 and G24 respectively. When Non-Corner Rounding Mode is active, D.C. drives must be in-position before Unidex II continues execution of the program. When Corner Rounding Mode is in effect, Unidex II will execute the commands but not wait for the D.C. drives to complete their move. In G23, after Unidex II has sent the clock pulses to the drives, it will notify the controller that it has executed the commands even though the drives may still be moving. This allows the next move to be set up while the drives are running the following error to zero,

thus giving faster execution of the program. G24 is selected by default on power-up and will remain in effect until cancelled by the G23 Command.

It should be noted that Corner Rounding is ineffective in the Local Mode since commands cannot be entered through the keyboard quickly enough. Similarly, operation at low feedrates is not effective since there is no following error. Also, the amount of rounding produced in the Remote Mode will vary depending upon the amount of information transmitted to Unidex II between commands or if bus speeds are slowed down by inefficient protocols or for other reasons. When used with stepping motor systems, unsatisfactory results may occur; in high speed stepper systems, the motors may be driven into resonance frequency regions.

5.2.4 RESET POSITION READOUTS AND DRIVES - G10 (NON-MODAL)

Command G10 resets both the Drives and the Absolute position registers. After execution of this command, all zeros will be displayed on the X and Y readouts. Entering the G10 Command will cause all previously entered X, Y, and M Commands to be cleared. However, if an X, Y or M Command is entered after the G10 Command but in the same block, the axes will make the specified move after the G10 Command is completed.

5.2.5 HOME - G7 (NON-MODAL)

The Home Command, G7, sends both Drives to the Home or Reference position. The Drive finds the Home position by moving in the CCW direction until the CCW limit switch is closed. The motor reverses direction and begins rotating CW. It will continue in the CW direction until the marker pulse is encountered. The first marker

pulse after the limit resets the system and this establishes the Home position. At this point, the Absolute position registers will be cleared and Unidex II will execute the Home Offset (U or V) moves if they have been previously entered. Entering the G7 Command will cause all previous X, Y, and M Commands to be cleared. However, if no Home Offset (U or V) is entered and an X, Y or M Command is entered after the G7 Command but in the same block, the axes will make the specified move after the G7 Command is completed.

5.2.5.1 HOME OFFSET (MODAL - PAIRED WITH ANOTHER OFFSET OR CLEAR)

If a reference point other than that available with the Home Command is desired, it can be programmed by means of the Home Offset feature. The procedure would be as follows:

Enter the X Home Offset (U), if desired, enter the Y Home Offset (V), if desired, and enter the Feedrate which should be used to move to the Home Offset position. Now, on execution of the G7 Command, Unidex II will take both axes Home and upon finding an active Home Offset Command, will move at the programmed feedrate to that Home Offset position. When the Drives are in position, the Home Offset position will be displayed.

Once a Home Offset is programmed, it will remain active until cancelled by another Home Offset Command or a CLR Command. Also, if no feedrate is entered and an attempt is made to execute a Home Offset, the Error 4 message will be displayed.

5.2.6 RESET ABSOLUTE POSITION REGISTERS - G5 (NON-MODAL)

The G5 Command is used to reset the Absolute position registers. It's primary use is for Absolute positioning since all Absolute Commands following G5 will use the location where G5 occurred as the

zero reference point. Entering the G5 Command will cause all previously entered X, Y, and M Commands to be cleared. However, If an X, Y or M Command is entered after the G5 Command but in the same block, the axes will make the specified move after the G5 Command is completed.

5.3 MISCELLANEOUS FUNCTIONS

There are 16 M Commands available on Unidex II for controlling four output lines and one input line. These commands are all Modal. They consist of the letter "M" followed by two digits.

5.3.1 CONTROL OF OUTPUT LINES 1 THROUGH 4

There are four output lines on Unidex II which can be controlled by the M Commands (each line is capable of driving one TTL load). These lines are designated #1 through #4 and comprise the second digit of every M Command (i.e. MA1, MA2, MA3, MA4; here A represents a single digit identifying the type of command). On power-up all lines are at a low TTL logic state. Once entered, M Commands remain in the machine until deleted.

5.3.2 M11 THROUGH M14, TURN ON OUTPUT (MODAL, PAIRED WITH M21 TO M24)

Commands M11 through M14 are used to turn the output line (specified in the second digit) ON (to a high TTL state). The output will be turned on upon execution. If any move is programmed in the same block with these commands, the respective output will be turned on before the move is started and will remain on until an OFF Command is issued for that line.

Example: To turn output line #2 ON, enter the following command: SHIFT M 1 2 ENT

On execution of this Command, Unidex II will turn output line #2

ON and it will remain ON until either the OFF Command is executed or Unidex II is reset.

5.3.3 M21 to M24, TURN OFF OUPUT (MODAL, PAIRED WITH M12 TO M14)

Commands M21 through M24 are used to turn the output line (specified in the second digit) OFF. The output will be turned OFF before the move and will remain OFF until commanded otherwise.

Example: To turn output line #4 OFF, enter the following command: SHIFT M 2 4 ENT

On execution of this command, Unidex II will turn output line #4 OFF.

5.3.4 M31 TO M34, TURN ON BEFORE AND OFF AFTER MOVE (MODAL, PAIRED WITH CLR)

Commands M31 through M34 are used to turn the selected output line ON before the move is executed and OFF after the move is executed.

Example: Enter the command: SHIFT M 3 1 ENT

Upon execution of every subsequent Move Command, output line #1 will turn ON, the move will be made, then the line will be turned OFF. The command is cancelled with CLR.

5.3.5 M41 TO M44, TURN ON AT END TILL CONTINUE (MODAL, PAIRED WITH CLR)

Commands M41 through M44 are used to turn the selected output line ON after the move is completed. That line will remain on until the CONTINUE line (refer to Table 2.8.1) makes the transition from high to low, at which time the selected output line will go low. Once this command has been executed, Unidex II will halt until the CONTINUE line changes state or the RES key is pressed.

Example: Enter the command: SHIFT M 4 3 ENT

On execution, the axes will be moved to their commanded position, output line #3 will be set high and Unidex II will wait for the

CONTINUE line to change state. When CONTINUE goes low, output line #3 will be set low and command execution will resume. The command is cancelled by CLR.

5.4 FEEDRATE

Feedrates are entered in units of 10 steps/second. The range of numbers that can be entered is from 1 to 5000 corresponding to feedrates of 10 steps/second to 50,000 steps/second.

Example:

To enter 10,000 steps/second, press: SHIFT F 1000 ENT

To enter 750 steps/second, press: SHIFT F 75 ENT

To enter 50 steps/second, press: SHIFT F 5 ENT

Feedrates below 250 steps/second will cause the displays to be updated continuously as the axes are moved. With feedrates of 250 steps/second or greater, the display will update only when the move is completed.

5.5 ORDER OF EXECUTION

When the EX key is pressed, Unidex II proceeds to execute the commands which have been entered in a specific order. This order of execution is as follows:

1. G60 and G61 are executed on entry
2. All G Commands in the following order:

   G91, G90, G24, G23, G10, G7, G5
3. All pre-move M Commands
4. The move is completed
5. All post-move M Commands

6.0 TROUBLESHOOTING

This section of the manual is presented to help the user detect and identify problems arising from either improper operation or hardware failure.

6.1 ERROR MESSAGES

Unidex II identifies errors arising from improper operation and displays an error number corresponding to the error detected in the following format:

Err XX - Where XX is the two digit error code as given in Appendix D

If Unidex II is in the Remote Mode when an error occurs, it will set the error bit in the IEEE-488 Serial Poll Status Byte and signal the remote bus controller. Please refer to Sections 4.4.6, 4.4.7, 4.4.8, and 4.5 for further details. Appendix D contains a listing of error numbers and their sources.

6.2 PROM ADDRESSING

The Unidex II operating system is contained on two 2732 EPROM's marked as M8 and M9 on the circuit board (refer to Figure 2.1). Their addressing range is as follows:

M8	M9
6000-6FFF	7000-7FFF

6.3 CONTROLLER PROGRAMMING (IEEE-488 INTERFACE)

Be sure you poll Unidex II after the first command, and every command thereafter, to reset the SRQ. If you service the SRQ with an interrupt, be sure that you handle the interface control registers in your Controller properly. Polling resets the SRQ in Unidex II; it likely will not reset the SRQ register bit in your Controller's interface. You will ordinally have to read the status of the proper register in your Controller's interface to do that.

APPENDIX A

IEEE-488 ADDRESS TABLE

Switch					Decimal Address
5	4	3	2	1	
Off	Off	Off	Off	Off	0
Off	Off	Off	Off	On	1
Off	Off	Off	On	Off	2
Off	Off	Off	On	On	3
Off	Off	On	Off	Off	4
Off	Off	On	Off	On	5
Off	Off	On	On	Off	6
Off	Off	On	On	On	7
Off	On	Off	Off	Off	8
Off	On	Off	Off	On	9
Off	On	Off	On	Off	10
Off	On	Off	On	On	11
Off	On	On	Off	Off	12
Off	On	On	Off	On	13
Off	On	On	On	Off	14
Off	On	On	On	On	15

Switch					Decimal Address
5	4	3	2	1	
On	Off	Off	Off	Off	16
On	Off	Off	Off	On	17
On	Off	Off	On	Off	18
On	Off	Off	On	On	19
On	Off	On	Off	Off	20
On	Off	On	Off	On	21
On	Off	On	On	Off	22
On	Off	On	On	On	23
On	On	Off	Off	Off	24
On	On	Off	Off	On	25
On	On	Off	On	Off	26
On	On	Off	On	On	27
On	On	On	Off	Off	28
On	On	On	Off	On	29
On	On	On	On	Off	30
On	On	On	On	On	31*

NOTE: Refer to Figure 2.1 for the on-off positions of Switches 1 through 5.

* Not Used

APPENDIX B

IEEE-488 CABLE MANUFACTURERS

Some manufacturers of IEEE-488 cables are listed below. This is only a partial list.

* Hewlett-Packard
  Pal Alto, California 94303

PN	Length
10631A	1 Meter
10631B	2 Meters
10631C	4 Meters
10631D	.5 Meters

* Belden Corporation
  Richmond, Indiana 47374

PN	Length
9642	1 Meter
9643	2 Meters
9644	4 Meters
9645	8 Meters
9646	16 Meters

APPENDIX C

REMOTE CHARACTER SET

Character	Hex-ASCII	Meaning
X	58	X Axis
Y	59	Y Axis
F	46	Feedrate
G	47	Preparatory Command
M	4D	Miscellaneous Command
0	30	----------
1	31	
2	32	
3	33	
4	34	Digits
5	35	0 - 9
6	36	
7	37	
8	38	
9	39	----------
D	44	Clear Function
U	55	X Home Offset
V	56	Y Home Offset
-	2D	Minus
, (Comma)	2C	Enter (Optional, Not Required)
H	48	Wait For GET (Trigger Mode)
CR LF	0D 0A	End Of Block
EOI	--	(End Or Identify) End Of Block

APPENDIX D

ERROR MESSAGES

Error #	Cause
1	Limit encountered
2	RESET key
3	Move Into Limit Commanded
4	F Function not active - Feedrate not entered
5	Invalid G Command entered
6	Invalid M Command entered
7	Invalid output line selected for M Function - must be N1 through N4 where N = 1, 2, 3 or 4
8	Not used
9	Number entered without command active
10	Previous command not terminated by ENT prior to new command entry
11	Feedrate out of range
98	RAM Test Error
99	Check Sum Error. Execute program has a fault.

APPENDIX E

IEEE-488 BUS INTERFACE FUNCTIONS

These are messages sent on the bus with the ATN line asserted. The bus functions listed below are valid only when Unidex II is in the Remote Mode or Remote Enable Mode as shown. If Unidex II is in the Local Mode, Bus Handshake Protocol may not be completed.

Bus Function	Unidex II Response
DCL (Not Addressed) SDC (Addressed)	Goes into Power-Up state if not already in that state.
GTL (Addressed)	Goes into Local Mode with Remote Enable. Position registers and previous command block are not cleared.
GET (Addressed)	Executes command block and sets SRQ If in Trigger Mode. No response if not in Trigger Mode.
SPE (Addressed) SPD (Addressed)	These two as components of a Serial Poll cause Unidex II to put out the status byte and reset SRQ if set.
UNL UNT MLA MTA LAG TAG	These are components of Data Transfers. They cause appropriate data transfer sequences.

Bus Function	Unidex II Response
IDY (Identify) (Parallel Poll)	Puts an '0' byte on the bus as a response to a parallel poll; transparent to Unidex II.
TCT (Addressed)	Bus hangs up.
LLO	No response.
UUCG (Undefined Universal Command Group)	No response.
UACG (Undefined Addressed Command Group)	

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Product: Unidex II, REV. C-6A Manual: Unidex II, REV. C-6A

Model No.: _____ Serial No.: _____

Drawing No.: _____

Please type or print:

_____ _____
Name Title

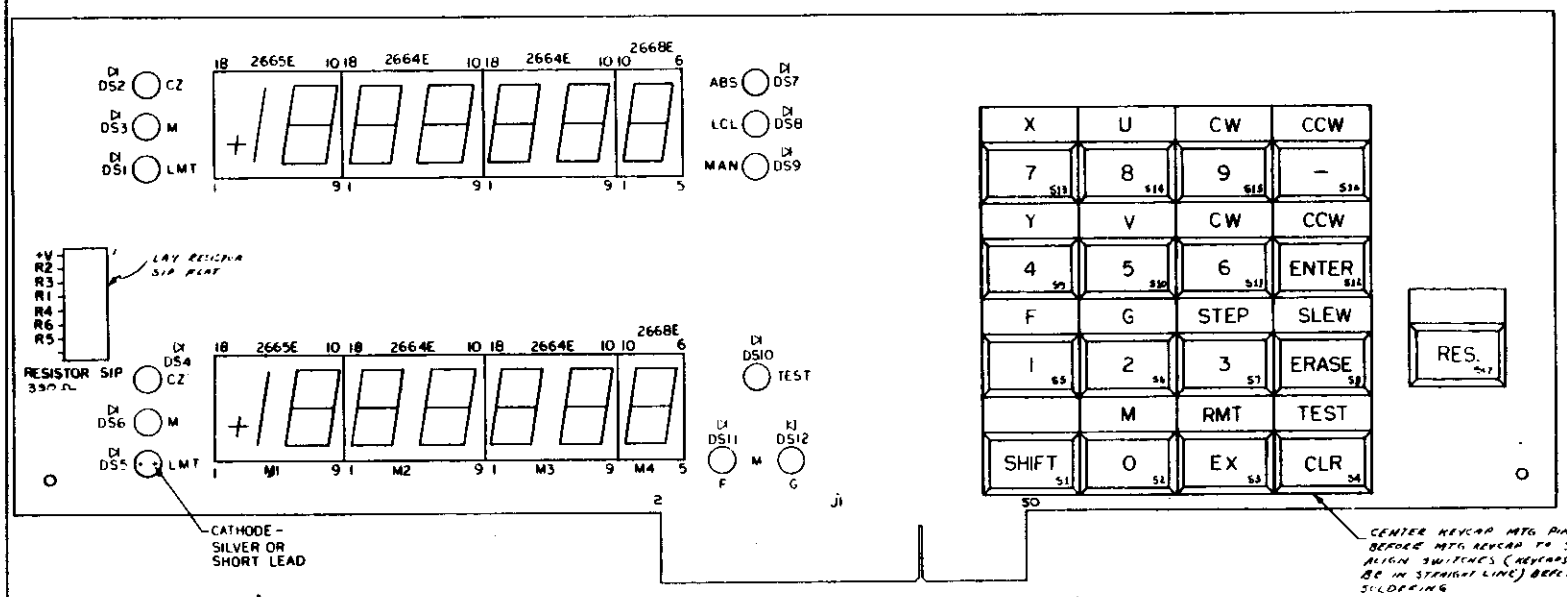
_____ _____
Company Division

_____ _____
Street Mail Drop ( ) Telephone Number

_____ _____
City State Zip Code

For Hardware and/or Software Support call: (412) 963-7470

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	REVERSED CONN. J1 MOVED DS7	9/16	T.T.



PIN 1 MI-M8

SCHEMATIC IS "C" SIZE .

1. SCHEMATIC IS "C" SIZE

NOTES

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	SPEC	MATERIAL OR NOTE
LIST OF MATERIAL				

MATERIAL	[ ] STEEL [ ] ALUM [ ] CRES [ ] SEE LIN OR P.L.	[ ] CASTING [ ] TURNING [ ] STRUCT [ ] SEE NOTE
FINISH	[ ] BLACK OXIDE [ ] BLACK ANODIZE [ ] ALODINE	[ ] CLEAR ANODIZE [ ] [ ] SEE NOTE
PAINT	DO NOT PAINT SURFACES MARKED PER AEROTECH SPEC OR PER	

APPLICATION | QTY REQD

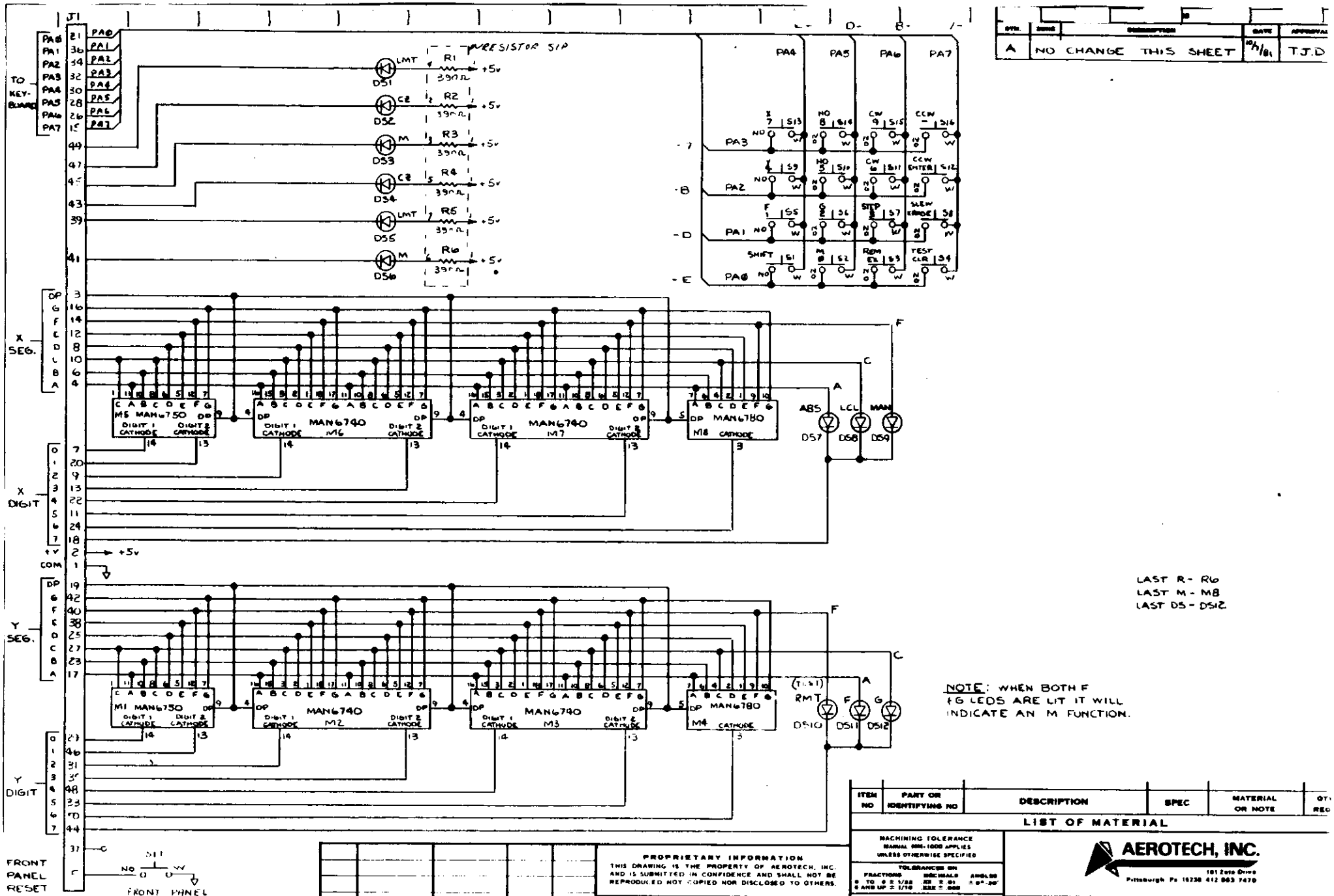
MACHINING TOLERANCE		
FRACTIONS ±	DECIMALS ±	ANGLES ±
FINISH		EXCEPT AS NOTED
DRAWN	T.J.D	DATE
CHECKED		
DESIGN		
ENGRG		
PROD		
Q.A.		
APPD		

AEROTECH, INC.

UNIDEX II KEYBOARD & DISPLAY CAR ASSEMBLY

CODE IDENT NO	SIZE	DWG NO
10B	D	690D1179

SCALE 2:1 WT SHEET 1



DWG.	ZONE	DESCRIPTION	DATE	APPROVAL
A		NO CHANGE THIS SHEET	10/1/81	T.J.D

LAST R - R6
LAST M - M8
LAST DS - DS12

NOTE: WHEN BOTH F & G LEDS ARE LIT IT WILL INDICATE AN M FUNCTION.

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	SPEC	MATERIAL OR NOTE	QTY REQ

LIST OF MATERIAL

MACHINING TOLERANCE MANUAL MACHINING APPLIES UNLESS OTHERWISE SPECIFIED

TOLERANCES ON FRACTIONS ± 1/32 DECIMALS .XX ± .01 .XXX ± .005 ANGLES ± 0°-30'

RMS FINISH ✓ EXCEPT AS NOTED

MATERIAL: ☐ STEEL ☐ ALUM ☐ CRES ☐ SEE L/M OR P/L ☐ CASTING ☐ TUBING ☐ STRUCT ☐ SEE NOTE

FINISH: ☐ BLACK OXIDE ☐ BLACK ANODIZE ☐ ALODINE ☐ CLEAR ANODIZE ☐ ☐ SEE NOTE

PAINT: DO NOT PAINT SURFACES MARKED ▼ PER AEROTECH SPEC ____ OR PER ____

DRAWN	T.J.D.	8/14/81
CHECKED		
DESIGN		
ENGRG		
PROD		
Q A		
APPD		

DASH NO	NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION			QTY REQD	

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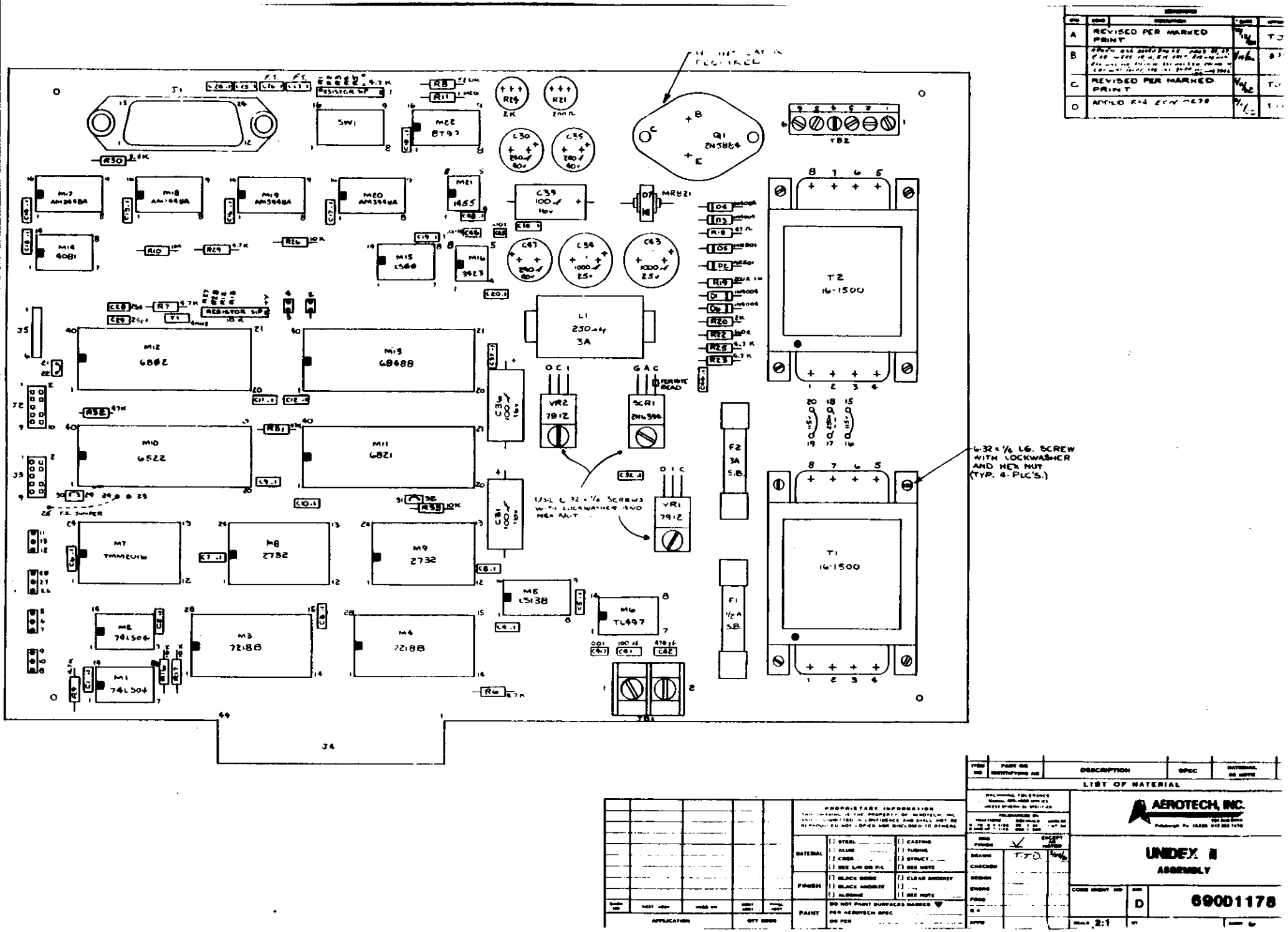
101 Zeta Drive
Pittsburgh Pa 15238 412 963 7470

UNIDEX II
KEYBOARD & DISPLAY CARD
SCHEMATIC

CODE IDENT. NO.	SIZE	
23	C	690C1179

SCALE ~ WT ~ SHEET 1



REV	DESCRIPTION	DATE	APPROVED
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B	[illegible]	7/16/82	[illegible]
C	REVISED PER MARKED PRINT	11/4/82	TJ
D	ADDED R24 ECN 0278	7/1/83	[illegible]

LIST OF MATERIAL

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FINISH [ ] BLACK OXIDE [ ] CLEAR ANODIZE [ ] BLACK ANODIZE [ ] [ ] NI-PLATE [ ] SEE NOTE

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UNIDEX II

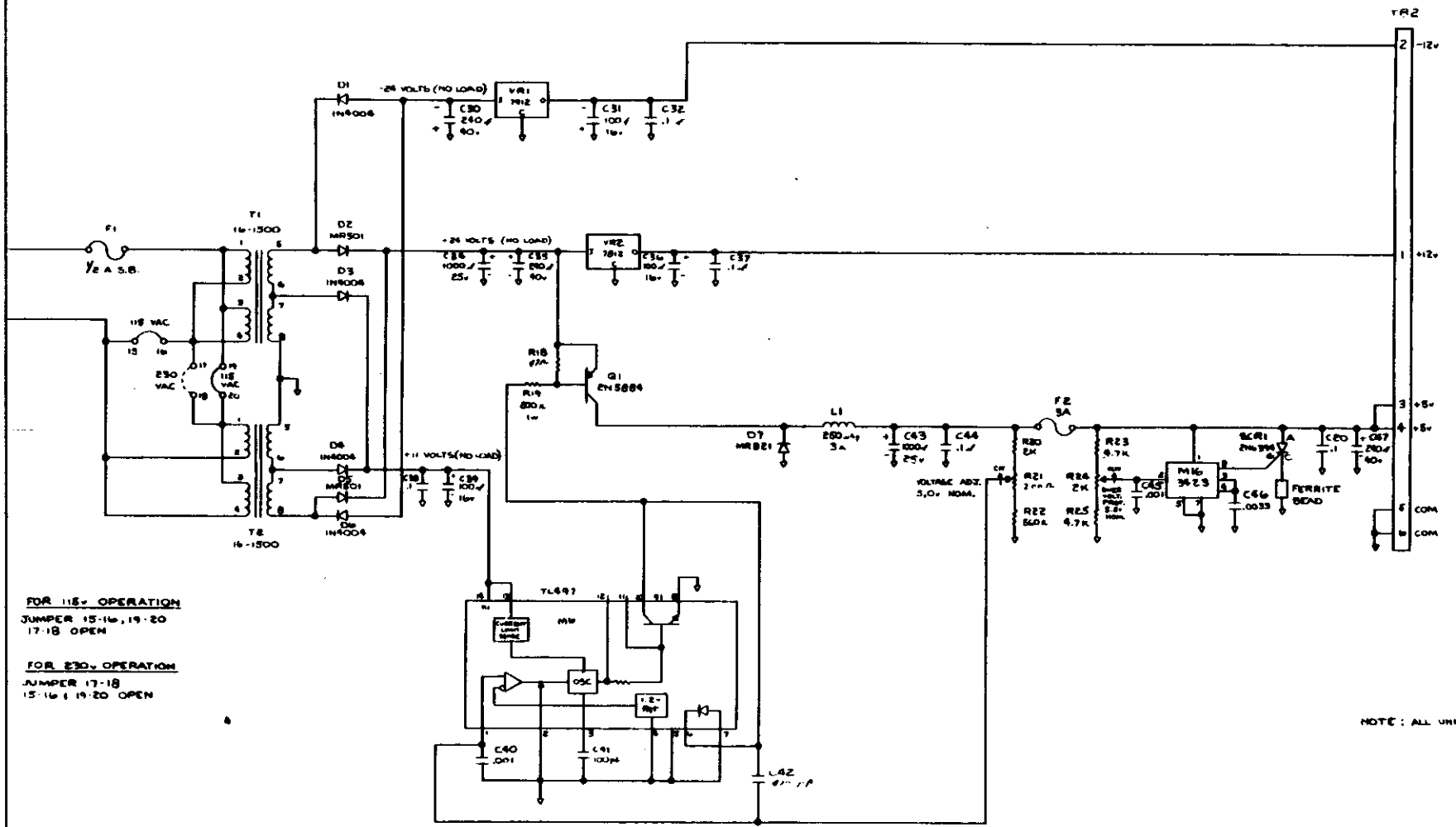
ASSEMBLY

CODE IDENT NO D

69001178

SCALE 2:1

A	REVISED PER MARKED PRINT		TJT
B			DJS
C	NO CHANGE THIS SHEET		TJT
D	NO CHANGE THIS SHEET		TJT



FOR 115v OPERATION
JUMPER 15-16, 19-20
17-18 OPEN

FOR 230v OPERATION
JUMPER 17-18
15-16 & 19-20 OPEN

NOTE: ALL UNMARKED RESISTORS ARE ¼ W.

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	SPEC	MATERIAL OR NOTE

LIST OF MATERIAL

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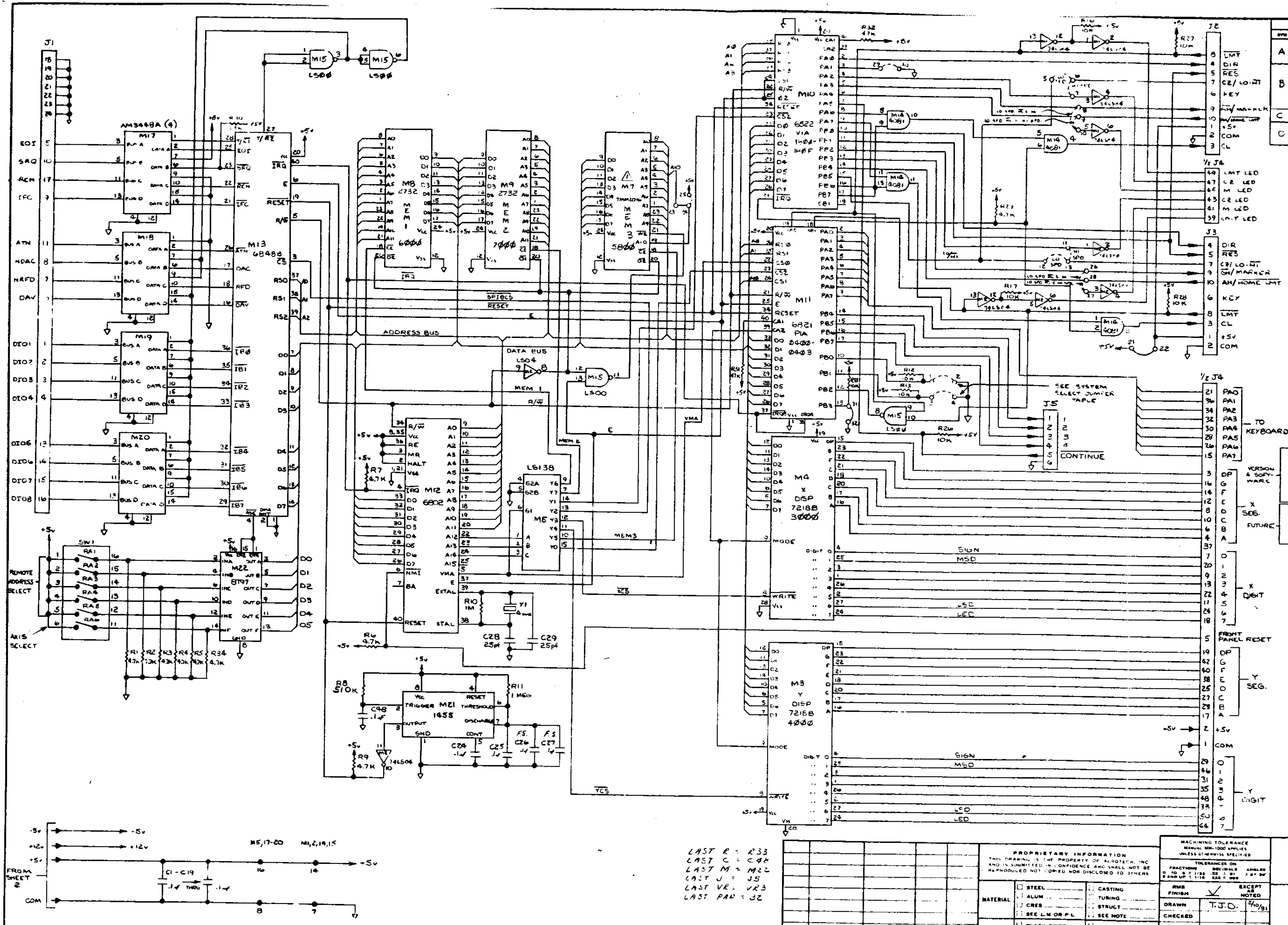
UNIDEX II
SCHEMATIC

CODE IDENT NO	SIZE	690D1178
98	D	

SHEET 2 OF 2



REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	REVISED PER MARKED PRINT	10/../81	T.J.D.
B	[illegible]	11/14/82	DJS
C	REVISED PER MARKED PRINT	4/../83	TJD
D	ADDED R34, ADDED CONN. M22-13,14 & SW1-6,11. ECN0278	8/../83	TJD

NUMBER OF AXIS USED

NUMBER OF AXIS	SW. 1 No. 6
TWO AXIS	OFF
X AXIS ONLY	ON

FUTURE

SYSTEM TYPE \ JUMPERS	1-2	3-4	5-6-7	8-9-10	11-12-13	26-27-28
HIGH SPEED STEPPER	IN	IN	6-7	9-10	11-13	27-2[illegible]
D.C. SYSTEM	OUT	IN	6-7	9-10	11-13	27-2[illegible]
LOW SPEED STEPPER WITH HOME CARD	IN	IN	5-6	9-10	12-13	27-[illegible]
LOW SPEED STEPPER WITH HOME LIMIT ONLY	OUT	OUT	5-6	9-10	12-13	27-2[illegible]
LOW SPEED STEPPER WITH HOME LIMIT AND MARKER	IN	OUT	5-6	8-10	12-13	26-27

VERSION & SOFTWARE

FUTURE

JUMPER 29 TO 30 FUTURE USE
JUMPER 31 TO 32 IN

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CODE IDENT. NO	SIZE	
9B	D	690D1178

SHEET 1