Mass Storage Devices 6

Contents

Introduction

The FAIRLIGHT Series III is available with various options for mass data storage peripherals. A typical system is provided with one floppy disc drive, one Winchester hard disc drive, and one streaming tape drive.

The floppy disc drive is either a Mitsubishi M2896-63 a YE DATA or a YE180, double-sided, double density soft-sectored 8-inch type.

The hard discs used are currently Maxtor or Newbury Data 85 or 140Mb Winchesters, and the streaming tape drive is Archive scorpion.

Floppy disc drive

Removal, installation and shipping of discs

Refer to the Page 6.19 for the Removal and Installation procedure. Insert the shipping disk that was shipped with the unit, and close the door, whenever reshipping the disk drives. A floppy disk will suffice as a shipping disk.

Disk Drive Optioning

Optioning may only need to be done if the disk drive has been returned to a Mitsubishi service centre. If returned to a Fairlight service centre, the drive will be correctly optioned to perform correctly on the C.M.I.

Mitsubishi M2896-63 - Option blocks to be shorted

JFC, PS, SE, DC, M2, S2, I, R, IT, MS,
M0, RFA, HR, A, HUN, WP, DS, 2S, RM

Additional wire link option - Y

YE180 - Option blocks to be shorted

C, Y, and the optioning block located near the terminating resistors.

YE180 - Option blocks to be open

X, Z, H

All other option blocks to be left open. See Figure 1 for option block locations.

Note - If two (2) floppy disc drives are installed drive 0 should have no termination resistors but drive 1 should. The termination resistors are located near the 50 way gold contacts.
Mitsubishi - MIGA 150ohms J x 1
YE180 - 760-3-150ohms x 2

Mitsubishi M2896-63 Option block Location

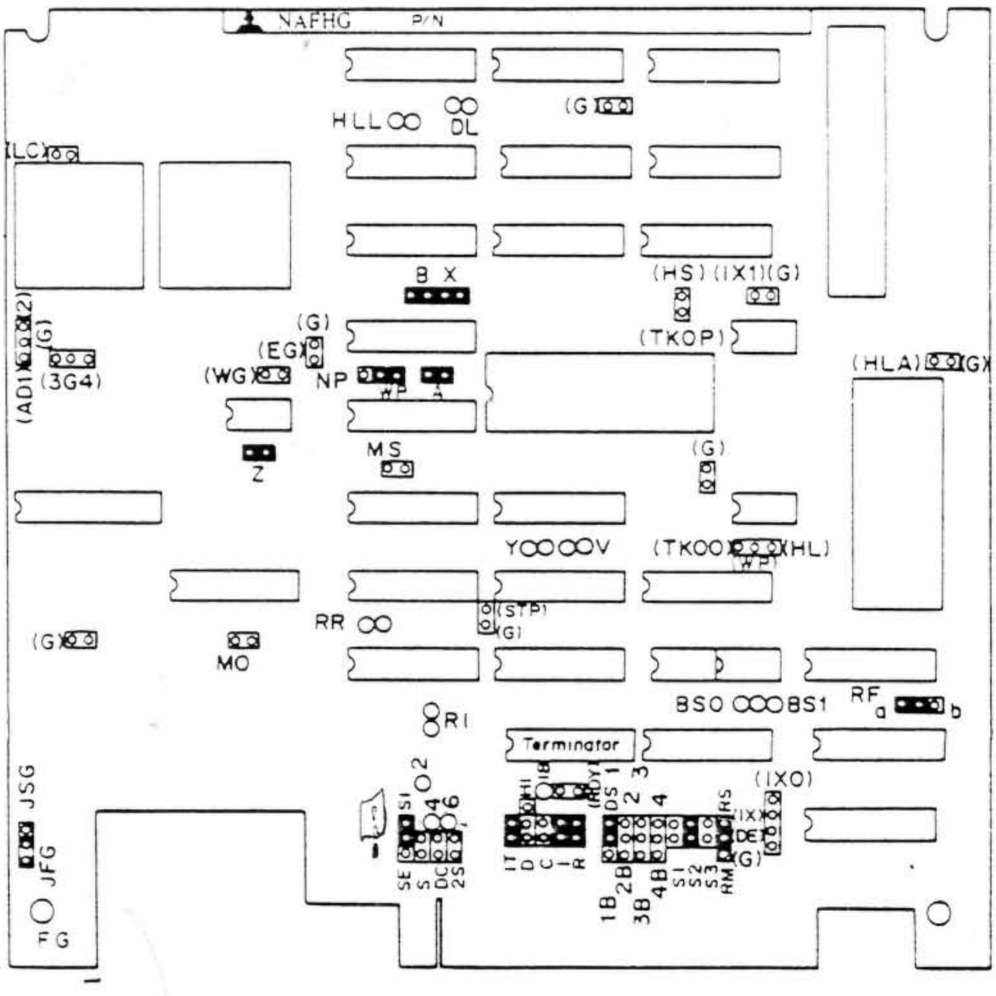


Figure 1

YE180 Option block Location

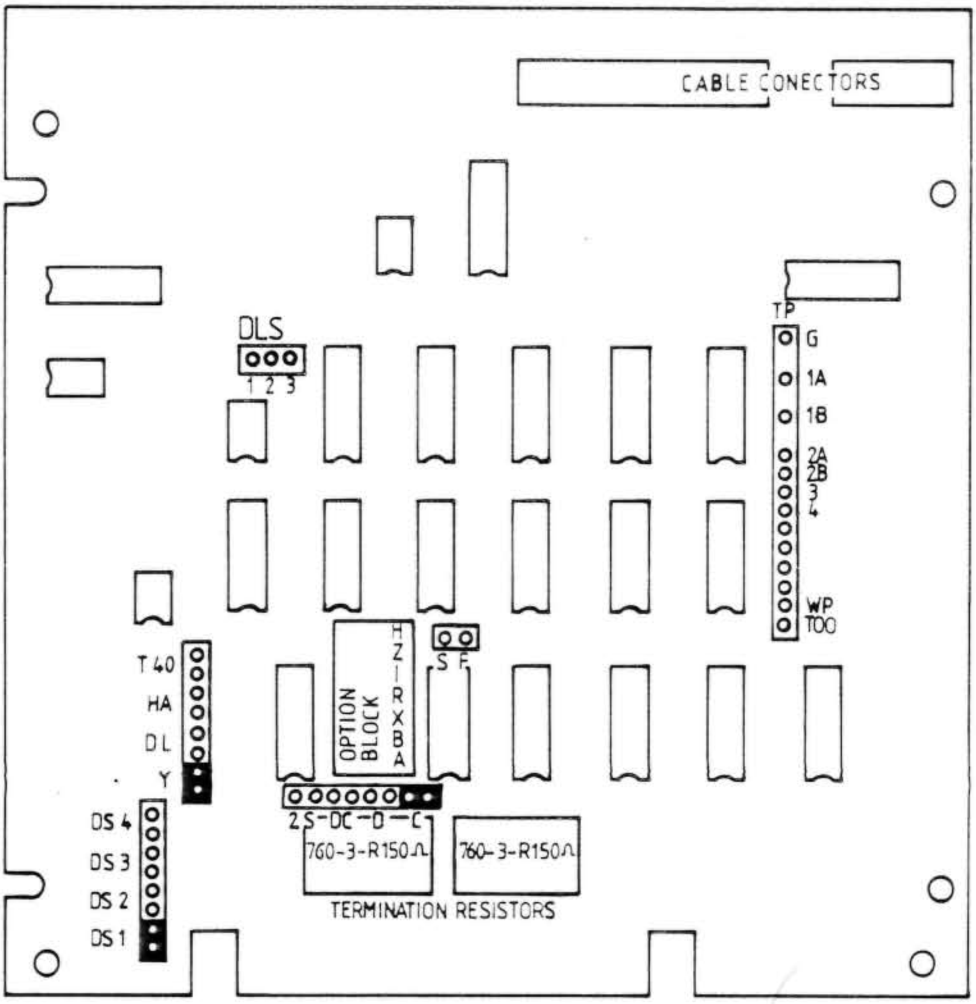


Figure 2

Disk Drive Alignment

Disk drives may require checking to account for any maladjustments which may occur during shipment. This requires the Fairlight Diagnostic Diskette containing the command DSKTST.CM.

The disk drive under test should be able to load test programs, however if the condition of the disk drive under test is suspect then another known good disk drive should be used to load the test program and used to run the tests on the faulty disk drive.

Radial Alignment

Because disk drives utilize double density disk format, radial alignment is critical and is best performed by Fairlight or Mitsubishi. To ascertain whether drive alignment is correct, run the DSKTST command from the Fairlight diagnostic disk.

Disc drive maintenance

Under normal circumstances preventive maintenance is not required on the M2896. If severely dirty environments are encountered, an occasional cleaning of the drive may be performed to assure continued reliable performance.

Only basic corrective maintenance is documented here. If it is determined that a disk drive requires more extensive repairs than are described in this section, return the unit to Fairlight Instruments for service. This document should provide sufficient information to determine whether return of the unit is necessary.

Preventative maintenance - Visual Check

Visual inspection is the first step in any maintenance operation. Always look for corrosion, dirt, wear, binds, and loose connections. Noticing these items may save downtime later.

Cleaning

Cleanliness cannot be overemphasized in maintenance of the M2896.

Caution

The head/carriage assembly is a factory-adjusted and tested assembly. Do not try to adjust or repair this internal component. Do not, for any reason, clean the read/write heads. To do so would cause severe damage to the head surfaces or head spring supports.

Floppy disk system diagnosis

The Floppy Disk System comprises of the QFC-9 Floppy Disk Controller as well as the disk drives themselves. The first step in servicing the system with an apparently faulty disk system is to establish in what subassembly the fault actually lies.

The general procedure to follow in disk system fault tracing is:

(1) Check all disk system cables, especially the 50 way flat cable for open circuits or shorts and ensure all connections are secure.

(2) Use the system test program CHECK to determine if the fault is in the drive itself (or the diskette) or the disk controller/DMA data transfer system.

(3) If the disk drive is faulty, use DSKTST to further analyse the fault.

(4) Otherwise, refer to the CMI Mainframe manual to trace the fault in the QFC-9 controller.

Test Program CHECK

Allows checking of;

- Cyclic Redundancy Check (CRC) errors
- Data transfer between memory and disk
- RAM bit corruption errors

Command Syntax

CHECK <UNIT>,<HEXNUM>;<OPTIONS>

where <UNIT> = <COLON><NUMBER>

<HEX DIGIT> = number 1 to 9 and/or letter A to F

e.g., CHECK<return> performs CRC on DRIVE 0.
CHECK :1<return> performs CRC on DRIVE 1.
CHECK :1;V<return> performs CRC on DRIVE 1 with V option.

1) Disk Integrity Check

Options: none required

This is the default CHECK routine. Entire disk in specified drive is read to check for CRC errors.

2) Read Data D.M.A. Verify

Option: V

Reads entire disk in specified drive twice, into separate blocks of memory and verifies data against itself.

3) Write Data D.M.A. Verify

Options: W,D (May be used together)

The W option creates a file, writes distinctive data to each sector of the file and reads each sector of the file back, twice, into different areas of memory for verification. All unfree disk space will be allocated to the file.

The D option is a destructive (to the disk contents) test which writes a unique "ADD -29" pattern to each sector in an interleaved fashion, reads it back, and verifies the data.

Interleaving of blocks ensures track boundaries are continually being crossed. A delay can be introduced using the "T" option (see below) to isolate head-load timing problems.

4) Other Options

Option	**Use with**	
R	W	use random number pattern instead of "29" pattern
P=XX	W	use pattern XX where XX = <hex number> write the pattern to disk, read back and verify
E=XX	all	print error if total recover-able where XX = <hex number>. Default value is 0.
T=XX	all	delay XX*10 ms. after a read/write where XX = <hex number>
C	all	test continously alternating between 'add-29' and a random number pattern
L	all	all error messages printed on printer

5) Error messages

a) Disk Read/Write Errors
These are of the form;

**PROM I/O ERROR -- STATUS = <status byte> AT h DRIVE i - PSN j

where h is not significant
i = drive number
j = physical sector number at which the error occurred

and the status byte can be interpreted as follows:

31 data C.R.C. error
32 disk is write protected
33 disk is not ready for some reason
34 deleted data address mark read
35 abnormal command termination
36 invalid sector address
37 seek error (track not found)
38 data mark read error
39 address mark read error

b) Verify Errors

When a verify error is encountered the offending disk sector is re-read into the QDOS sector buffer and matched against system RAM to determine where the error came from. The program then reports the corresponding address in RAM, the data expected, the erroneous data, the physical sector number of the disk where the error occured, and the byte offset within the sector.

6) Termination

Test is terminated by -
ESC key (sets system error status word)
More then 20 errors logged
User supplied iteration counter expired (default 1)

System error status word will be set if any error condition has been reported.

Test Program DSKTST

DSKTST comprises of five main test routines and a number of utility commands. The main routines are as follows -

#1 Write/read test (destructive)
#2 Read C.R.C. test (non-destructive)
#3 Worst case seek test (non-destructive)
#4 Worst case data pattern R/W (destructive)
#5 Sector/drive uniqueness (destructive)

CAUTION

Destructive tests will overwrite the diskette in the drive under test with a testing pattern.

Tests can be run separately or in destructive/non-destruct groups by typing as follows:

DN, (0 or 1 or B) [,X]<CR> (Do all non-destruct tests)

DD, (0 or 1 or B) [,X]<CR> (Do all destructive tests)

ST#<tests>,(0 or 1 or B)[,X]<CR>
where <tests> = up to 10 test numbers separated by '-'

The extended test option X accumulates error counts over a number of passes.

ESC key will abort test in progress.

Typing OS<return> will return the user to QDOS and reboot the system.

Examples: DN,0<return> does all non-destructive tests on drive 0 only.

ST#1-3-5,B,X does tests 1,3 and 5 on both drives with error count accumulation.

If stop on error option is selected (in answer to a prompt) the user may choose -

C continue
L loop
R reset stop on error

if an error stop occurs.

Error reporting
Error printouts take the following form :

<drive no.> <error type> <track no> /<physical sector no> <*>

Presence of '*' indictes a "hard" disk error,

e.g. 1 E3 1F /0325 *

means :- drive no 1
error type 3 (E3)
track no 1F
p.s.n 0325
error was not recoverable on retry (*)

If after three retries the error persists, it will be logged as a hard error (indicated by *).

Error types are as follows (per QDOS ROM codes):
- E1 data CRC error
- E2 disk is write protected
- E3 disk is not ready for some reason
- E4 deleted data address mark read
- E5 abnormal command termination
- E6 invalid sector address
- E7 seek error (track not found)
- E8 data mark read error
- E9 address mark read error

Additional error types are :-

- E@ data read back is not the same as data written

Additional error types from the drive uniqueness test are :-

- EA body of data buffer is not zero after test data
- EB unique data for this drive/sector is incorrect.

Error Graphs
Errors may be summarised by use of the 'PG' command. This summary plots the track no. as the vertical ordinate and the number of errors as the horizontal ordinate.

A horizontal line may contain up to 11 error types (codes) with each character representing (n*horizontal scale) errors.

The error graph is divided into two blocks. The left hand block relates to drive 0 errors, the right hand block to drive 1.

The graph is printed starting at the first track with errors logged and finishes with the last track with errors logged.

To stop the display rolling off the screen, <control W> can be used to stop printing. Subsequent carriage returns will print a little at a time, an escape will terminate the 'PG', and any other character will resume continuous printing.

In the case of double sided systems, each disk 'cylinder' is considered as two tracks, so even track numbers correspond to side 0 of the disk and odd track numbers correspond to side 1.

Utility Commands
Commands for utility programmes are as follows

HD,d,hhhh	Head load timing test on drive d at speed hhhh (100 mS = D8F0)
IX,d	Index sensor alignment test on drive d. t1=tk 1. t2=tk 76.
AT,d,s	Read data amplitude test on drive d. s is optional side select (0 or 1). t1=tk 0. t2=tk 76.
RA,d,s	Radial alignment test on drive d. s is optional side select (0 or 1) t1=0-38. t2=77-38. t3=39-38. t4=37-38.
AZ,d,s	Head azimuth test on drive d. s is optional side select. t1=0-76. t2=75-76.
T0,d	Track zero sensor alignment test on drive d. t1=1-2 lp. t2=0-1 lp. t3=0-2 lp.
SK,d,s	Head skew test on drive d. s is optional side select (0 or 1). t1=1-76 lp.
RS,d,hhhh	Read sector hhhh from drive d to buffer
WS,d,hhhh	Write buffer to sector hhhh on drive d
DB	Display buffer in hex and ascii
FB,hhhh	Fill buffer with repeating pattern hhhh

The running test may be aborted by escape key.
The next test of the sequence is entered by depressing space key.

Tests followed by letters "lp" move head between tracks shown.

Some tests require the appropriate alignment diskette and ask that it be inserted. Other tests require a scratch diskette and ask that it be inserted.

Typing OS<return> will return the user to the operating system (reboot).

Floppy disc removal

1. Remove top, bottom and blank plate on the rear of the CMI.
2. Place the machine upside down and remove the CMI-310 Card.
3. Remove the two(2) holding screws underneath the CMI-310 securing the floppy drive.
4. Place the machine on its feet.
5. Disconnect the 50 way cable and the four(4) pin power connector from the floppy drive.
6. Remove the two(2) screws holding the drive to the top plate.
7. Remove the floppy drive through the front of the frame.

Floppy Drive Re-assembly

1. Replace the drive through the front of the frame.
2. Install the screws which secure the drive to the top plate.
3. Re-connect the four(4) pin power cable and the 50 way signal cable.
4. Place the machine up-side down.
5. Re-install the CMI-310 card and all the cables.
6. Power up the machine and check for correct operation.
8. Refit the panels.

Note: The machine is placed upside down instead of on its side so that screws do not accidently fall into the switchmode power supply unit.

Introduction

The following information has been included to reduce the risk of damage to the hard disk due to mishandling.

Power Failure

Failure of either of the DC voltages (+12, or +5VDC) will cause an emergency retract. (ie withdrawal of heads to the landing zone.)

Practical Tips

Many problems occur during the installation and commissioning of equipment before experience with a product has been acquired. Common points regularly causing difficulties include:

1. Drive unit number Select Link **not fitted** in the appropriate position.

2. Terminator **not fitted** to the last drive in a daisy chain configuration.

3. Terminators **not removed** from all except the last drive in a daisy chain configuration.

4. Connectors **not fitted** correctly to cables or not pushed fully into drive connections. Make sure you fit polarising keys to your cable connectors.

5. If the drive does not run-up check that power to the drive is on.

6. Do not operate the drive after large changes of temperature. For example, if a drive has been brought from very cold conditions and installed in a warm area allow an hour for thermal stabilisation before powering up.

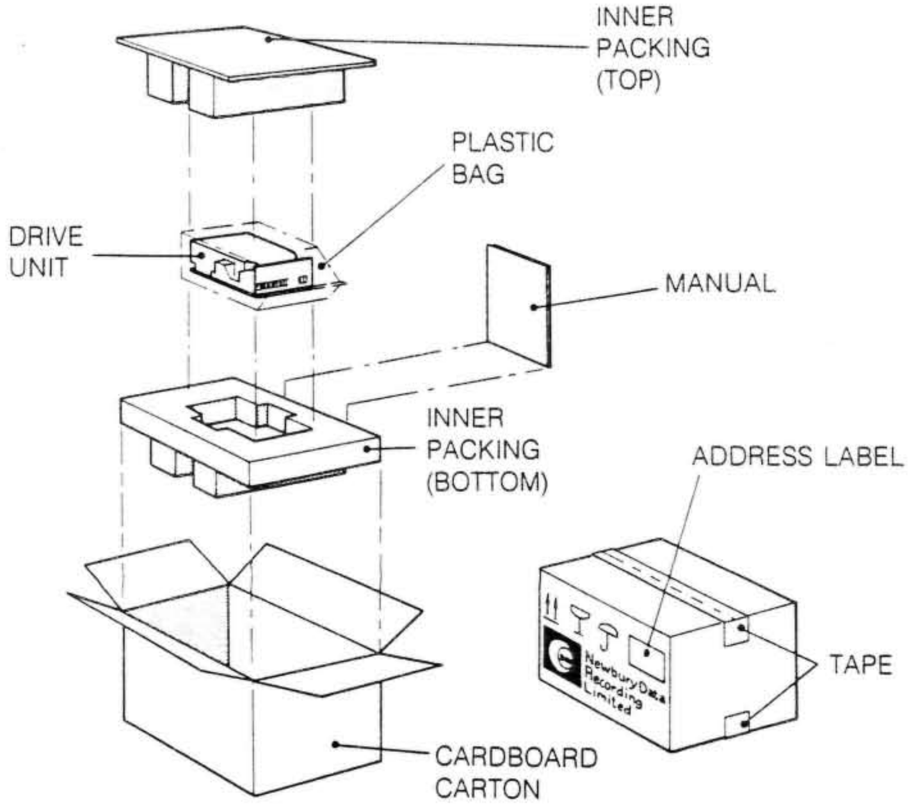
7. Avoid rough handling of the drive.

8. Avoid moving the drive when the spindle is running down as this could result in the heads contacting and damaging the moving disc surface. The discs take about half a minute to come to rest after the power has been switched off.

9. Always allow some spare capacity when allocating files to the drive. On any disk surface a few small media flaws occur either inherant from new or which have developed during use. Each of these cases can result in data not being reliably recorded or retrieved so a method of avoiding these areas is necessary. Normally the host system will find defective areas through the use of an error detection scheme and will allocate alternative locations. Note that this requires spare sectors to be available.

Packing and Unpacking hard disc

If a hard disk has to be replaced the following instructions should be followed. The drive is shipped in a sealed container as shown in the diagram below. This is designed to protect the drive from humidity, vibration and shock.



Upon receipt of the unit from the carrier, inspect the container for damage, then open the container and unpack the drive. Save all packing materials in case reshipment becomes necessary. Labels on the drive and on the packaging contain serial and part numbers. This information must be quoted in any communications about the drive.

> **NOTE**
>
> With no power applied to the drive the heads are automatically positioned over the non-data , dedicated landing zone on each disc surface The automatic shipping lock solenoid is also engaged.

Operating environment
The drive is designed to operate in a standard office environment. High relative humidity conditions should be avoided to prevent the possibility of condensation. Also avoid low relative humidity conditions to prevent particle accumulation by static attraction. The drive is not intended for use in a harsh environment with high dust and dirt concentrations.

The system is booted from the special CMI initialisation floppy disk. When the system is loaded and the Shell prompt appears, type:

CMI INIT<CR>

A query appears:

Initialize SCSI drive /SC00 (/K0, /K1, /C0) (y/n)?

To continue, type:

Y<CR>

A heading will appear:

*************Adaptec hard disk format program***************

Enter drive type:

At this point, if you have not already done so, examine the hard disk drive and note the drive model number (e.g. xt1140, NDR1140, xt1085, V185), the serial number and the error map. These should all be printed on the drive's outer casing. If you make a mistake in this step, a list of valid drive types appears. Match your drive type to one of the entries in this list and type the entry, followed by a <CR>. Next you will see:

Enter serial No:

Type the serial number you have noted. The next prompt is:

Clear the defect buffer: (y/n)

Type:

Y<CR>

The next prompt is:

Enter defect list - HEAD CYLINDER BYTE ,<RETURN> <RETURN> TO END

Type in the error map numbers in the order indicated. When the list is completed, type a second carriage return to exit the defect list editor:

<CR>

When completed a prompt reading:

Edit defect number:

will appear on the screen. You may now correct any errors due to typing inaccuracies, by typing first the number of the entry, then typing the entry. Strike <CR> to exit this editor. The screen will then read:

`Is the the defect list now correct and complete (y/n)?`

Type:

`Y<CR>`

`A hard format will completely erase all disk data - proceed (y/n)?`

Type:

`Y<CR>`

Note: Now you have typed in your error map there is no need to repeat the defect listing procedure when formatting the same disk in future. The defect map is saved in the root directory of the CMIGEN floppy disk under a name starting with `map_` followed by the drive type and serial number of the hard disk as entered above, e.g.

`map_xt1140_1120`

Formatting with an existing error map on the floppy disk.

This is essentially the same procedure as above. The `CMI_INIT` program detects the existing map corresponding to the drive type and serial number you enter and allows you to edit the existing map rather than typing a new one in. After entering the serial type, the query appears:

`Use existing defect map file: (y/n)?`

Type:

`Y<CR>`

There is a query:

`Add more defects:(y/n)?`

If you have extra defects to add to your file add them at this point. Then the procedure is as before:

`A hard format will completely erase all disk data - proceed(y/n)?`

Type:

`Y<CR>`

The hard disk will take approximately 15 minutes to format.
No more user prompts are required.

Hard disk removal

1. Remove top, right side, bottom and the blank plate on the rear of the CMI.

2. Place machine upside down and remove CMI-310 Card.

3. Locate the five (5) holding screws (underneath CMI-310) of the disk mounting plate and remove.

4. Place machine on its feet.

5. Disconnect the 50 way SCSI connector and four (4) pin power connector from Hard Disk and Adaptec controller, and the two (2) pin connector from the Hard Disk fan.

6. Remove faceplate and grill of the Hard Disk (at the front of the CMI).

7. Remove the six (6) screws holding the Hard Disk assembly to the top plate.

8. Remove Hard Disk assembly through the side of the frame.

Hard disk re-assembly

1. Replace hard disk tape assembly through the side of the CMI.

2. Re-connect the 4-pin power cables to the hard disk and note that two (2) power cables go to the tape assembly.

ENSURE THE CABLE TO THE FAN IS CONNECTED

3. Install the screws which secure the top of the hard disk tape assembly.

4. Place machine upside down.

5. Re-install the five (5) screws on the bottom of the hard disc assembbly.

6. Re-install the CMI-310 card and all cables.

7. Power up machine and check for proper operation.

8. Refit panels.

These steps are illustrated on the hard disk exploded diagram on the **next page**

Introduction

The Streaming Tape unit consists of an Archive Scorpion drive with an Emulex controller mounted in a single frame adjacent to the Hard Disc drive. The Tape unit is physically the same size as the Hard Disc and mounting and cabling notes referred to in the Disc section are applicable.

Handling

The Tape unit is more robust than the Disk, however it must always be handled gently. The head assembly of the tape drive is particularly sensitive and any excessive flexure may result in loss of alignment causing data errors.

Cables

Note that the Streaming Tape unit requires two power cables to operate correctly. The 50 way SCSI cable must be plugged into the Emulex controller board which mounts above the tape drive.

Controller

The Emulex controller is normally an integral part of the Tape unit and requires no attention, however in some cases it may be necessary to separate the controller and the drive. The following points should be observed carefully.

1. Remove/attach the controller board by adjusting the 4 Allen screws holding it in place.
2. Note the ribbon cable between the controller and the drive.
3. Ensure the terminating resistors are NOT in the controller card.
4. SW1 should only have pos1 and pos5 set to be ON.
5. Jumper E-F should be shorted.
6. Faulty controller boards should be returned for replacement.

Maintainance

Apart from normal head maintainance (ie. cleaning) there is no maintainance procedure. A drive which has been determined faulty must be replaced.

Adaptec Controller

The adaptec ACB-4000A controller is part of the Hard Disk assembly. The controller requires one power cable and connects to the 50 way SCSI ribbon cable. The controller connects to the disc via a 34 way cable and a 20 way cable. Secure connection of all these cables is necessary for reliable disc operation. The only practical method of determining controller malfunction is by board swapping. In the unlikely event of failure, the faulty board must be replaced.

Alphanumeric Keyboard

7

Contents

CMI-314 Power Supply Adapter

Graphics Pad Alignment

Introduction

The PREH alphanumeric keyboard has been modified for use with the Fairlight Series III CMI, from keyboard Rev. 1.56 onwards:

-The key layout has been changed slightly to incorporate the new ADD(sharp), SUB(flat), SET(natural) and CLEAR keys.

-SHIFT and CTRL can now be used with the graphics pad.

-New graphics and key control codes overcome the problem experienced by some users of characters being detected by the CMI when the graphics pen is used.

The modified keyboard internal software (in ROM) requires that the user have a CMI system of version 2.03m or later. Systems from v2.03m onward expect to use the new keyboard by default. IF YOU DO NOT HAVE A MODIFIED KEYBOARD(ie revision nr 1.56 or later) the system may be converted to use the older keyboard software by typing "/k0/oldkbd". The system may be converted back to using the newer keyboard software by typing "/k0/newkbd".

Keyboard diagnostic mode

A diagnostic mode has been added-keys or graphics pad frames now cause ASCII to be sent, enabling the key/graphics pad operation to be easily checked. Entering the diagnostic mode causes the string "Build .1>/null" to be sent, hence it is best used with OS9 running.

To use diagnostic mode

Exit to OS9 if currently in the CMI system. Toggle the keyboard into diagnostic mode by pressing key combination:

CTRL/SHIFT/REP/DEL (ie all at the same time!)

The keyboard should send the string "Build .1>/null" and print a message with its revision number.

If nothing happens, the keyboard probably hasnt been updated to version 1.56 or later.

If the system hasn't received the build command properly it will try and act on the diagnostic messages (ie the disk will be accessed every time a complete diagnostic message is received), so if this should happen toggle the keybard out of and back into diagnostic mode by pressing the

CTRL/SHIFT/REP/DEL key combination twice(slowly).

Pressing a key will cause the keyboard to send the name of the depressed key, enabling operation of all key switches to be checked.

Touching the pen on the graphics pad will cause graphics pad data to appear on the screen. Check that the data responds to the pen button, the SHIFT and CTRL keys, and pen up/down, and that the 'X' and 'Y' coordinates may be varied from 0 to 3ff (hexadecimal).

Toggle the keyboard out of diagnostic mode by pressing

Introduction

The PREH power supply adaptor is used to allow the new keyboard to operate from unregulated voltages available from the toroidal transformer in the series III. The PREH keyboard is an alpha-numeric type keyboard with a graphics tablet and pen for manipulating a cursor on the screen. This description of circuit operation applies only to the power supply adaptor card. For information or servicing of the keyboard electronics FAIRLIGHT or PREH, the manufacturer, should be contacted.

Input/Output

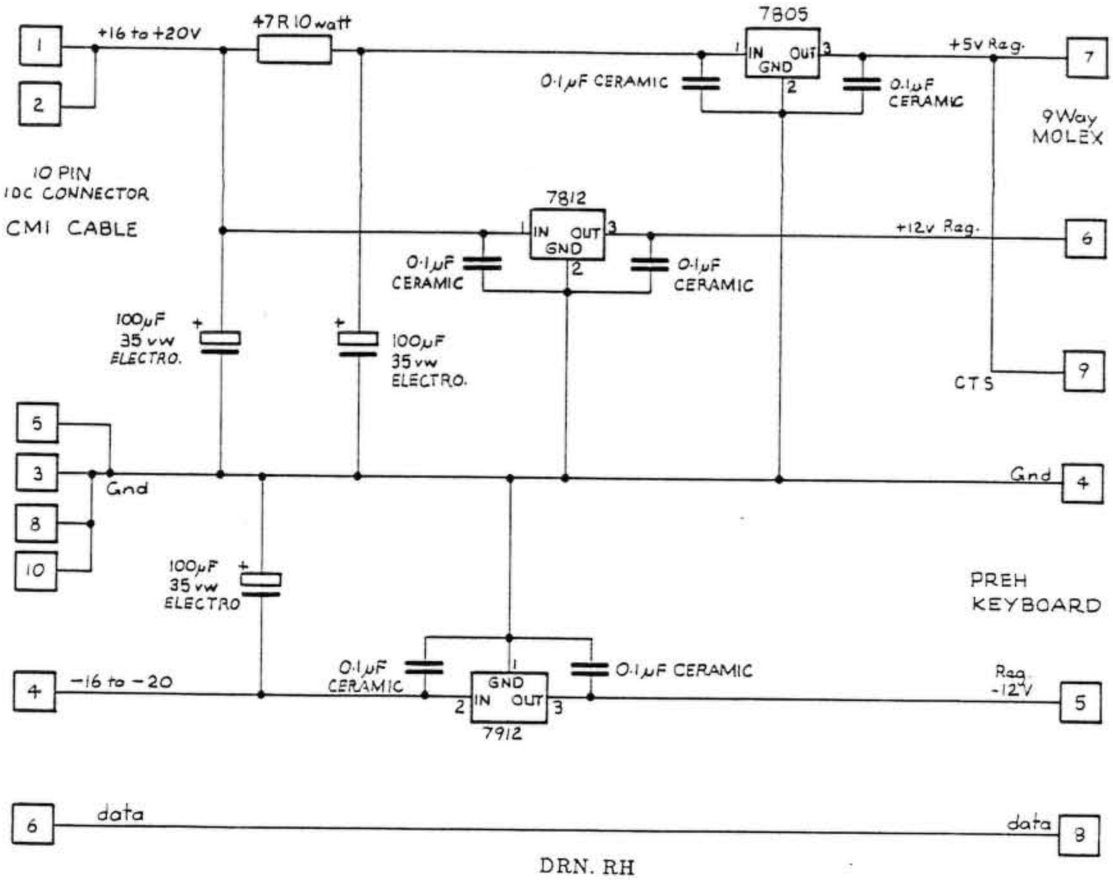
The power supply receives + and - 16volts and returns regulated +5, +12 and -12volts. The circuit board is carried within the PREH keyboard bolted to the aluminium key chassis which acts as a heatsink. The on board regulators of the keyboard are not used due to inadequate heatsinking of the +5volt IC regulator.

Circuit Description

(Refer schematic CMI314-0)

Incoming voltage in the range +16 to +22 is smoothed by a 100uF electrolytic and fed to a 7812 12 volt regulator. The same supply feeds through a 47R 10watt resistor to dissipate some heat, filtered by another 100uF and regulated by a 7805. The -12 volt supply is smoothed in a similar manner however a 7912 regulator is used.

Note: CMI314 carries the data and supplies the keyboard with the necessary CTS signal for correct operation



DRN. RH

Graphics pad alignment

The alignment may be carried out either in the CMI system by viewing the cursor on the screen, (for keyboard ROMs KBV1.56 onwards only) in OS9 by using the keyboard in its diagnostic mode.

Alignment in the CMI

1. Lightly mark the top right and bottom left corners of the exposed graphics pad (eg with soft pencil) before removing the top, so that the allowable pen movement range may be readily seen. Remove the four screws from along the top rear of the keyboard casing, and lift off the top cover.

2. Boot the CMI system so that the graphics cursor may be seen on the screen.

3. There are FOUR adjustable potentiometers along the top of the main printed circuit board. Touch the graphics pen in the bottom left corner of the pad on the mark made in Step 1. **Note:** Touching the pad slightly inside the mark (i.e 1-2 millimetres) will ensure that adequate graphics cursor movement is obtained.

4. Adjust the LEFTMOST potentiometer so that the cursor is just on the bottom of the CMI screen.

5. Adjust the RIGHTMOST potentiometer so that the cursor is just on the LEFT edge of the CMI screen.

6. Touch the pen in the top right corner of the pad.

7. Adjust the potentiometer which is second from the LEFT so that the cursor is just on the TOP of the CMI screen. Do not move the already set potentiometers!

8. Adjust the potentiometer second from the RIGHT so that the cursor is just on the RIGHT hand edge of the CMI screen.

9. Replace the top cover temporarily and check that the pad can move the cursor over the whole screen. If not, repeat steps 3 to 8.

Alignment in OS9

1. Repeat step 1 above.

2. Exit to OS9 if currently in the CMI system.Toggle the keyboard into diagnostic mode by pressing key combination CTRL/SHIFT/REP/DEL (ie all at the same time!). The keyboard should send the string "Build .1>/null" and print a message with its revision number.
   If nothing happens, the keyboard probably hasnt been updated to version 1.56 or later.
   If the system hasn't received the build command properly it will try and act on the diagnostic messages (ie the disk will be accessed every time a complete diagnostic message is received), so if this should happen toggle the keybard out of and back into diagnostic mode by pressing the CTRL/SHIFT/REP/DEL key combination twice (slowly).
   Note that touching the pen on the graphics pad will cause graphics pad data to appear on the screen. Check that the data responds to the pen button, the SHIFT and CTRL keys, and pen up/down, and that the 'X' and 'Y' numbers change as the pen is moved.

3. There are FOUR adjustable potentiometers along the top of the main printed circuit board. Touch the graphics pen in the bottom left corner of the pad on the mark made in Step 1. **Note:** Touching the pad slightly inside the mark (i.e 1-2 millimetres) will ensure that adequate graphics cursor movement is obtained.

4. Adjust the LEFTMOST potentiometer so that the 'Y' data just becomes 000.

5. Adjust the RIGHTMOST potentiometer so that the 'X' data just becomes 000.

6. Touch the pen in the top right corner of the pad.

7. Adjust the potentiometer which is second from the LEFT so that the 'Y' data just becomes 3ff (this is the Y cordinate in hexadecimal). Do not move the already set potentiometers!

8. Adjust the potentiometer second from the RIGHT so that the 'X' data just becomes 3ff.

9. Replace the top cover temporarily and check that the pad can change both 'X' and 'Y' data from 000 to 3ff. If not, repeat steps 3 to 7.

10. Toggle the keyboard out of diagnostic mode by pressing

    CTRL/SHIFT/REP/DEL.

11. Replace the four screws in the bottom casing.

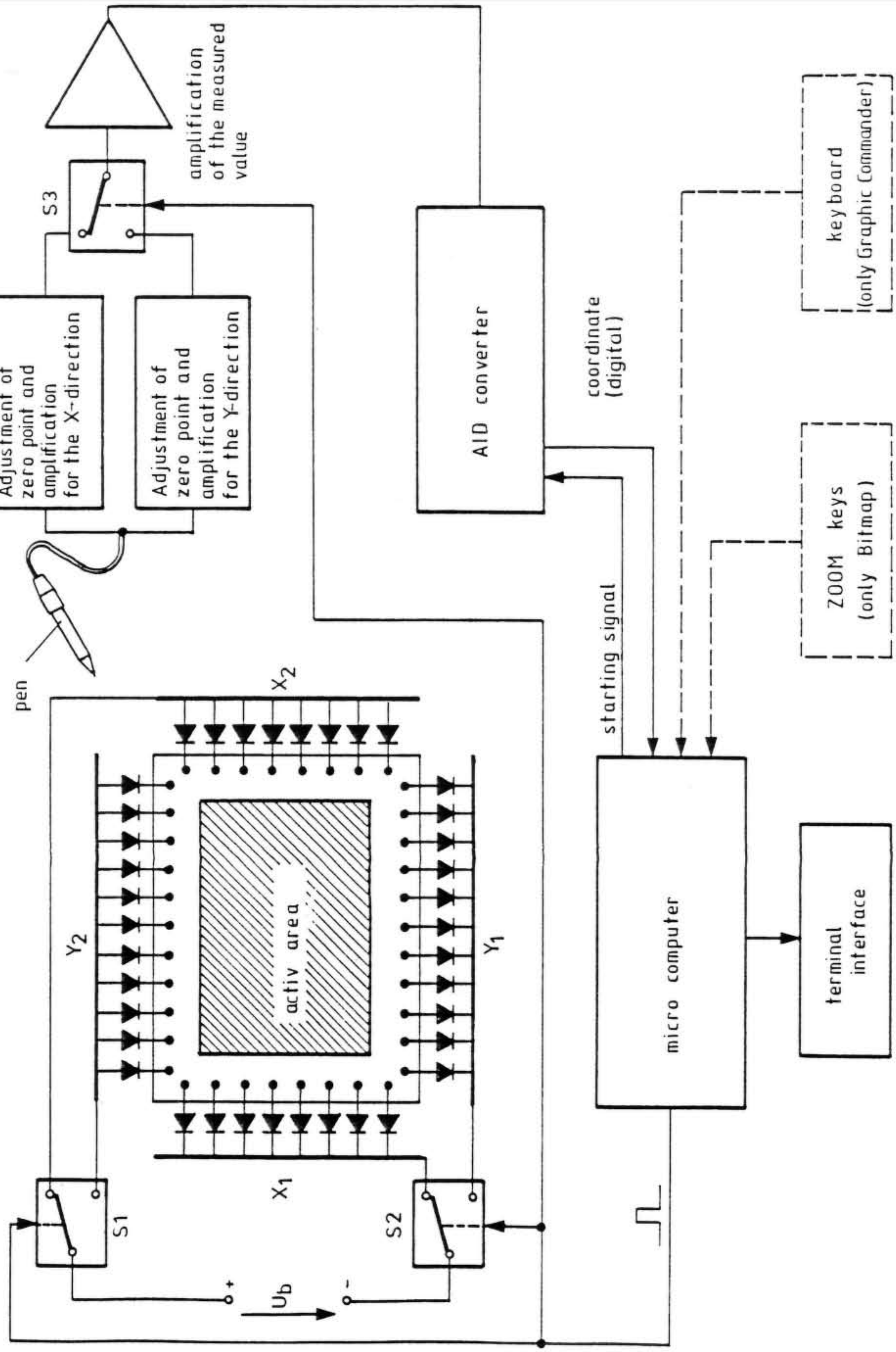
Graphics data frame format

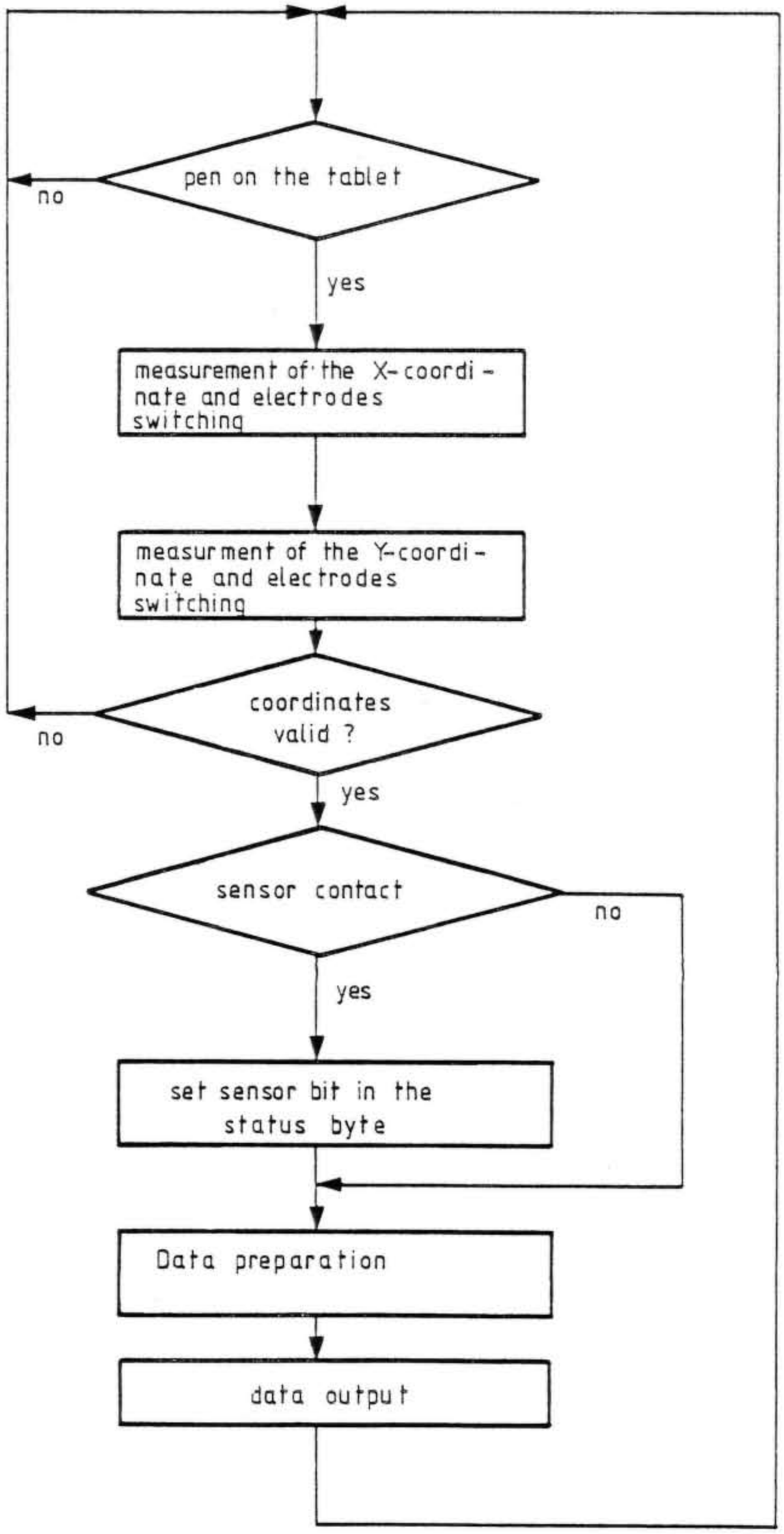
For each X/Y coordinate a frame of six bytes is sent:

byte 1: 10000000	control byte
byte 2: 111ptsc0	status byte s=SHIFT key down c=CTRL key down t=TOUCH sensor on p=PEN on pad
byte 3: 111xxxxx (low)	
byte 4: 111xxxxx (high)	X coord (10 bits)
byte 5: 111yyyyy (low)	
byte 6: 111yyyyy (high)	Y coord (10 bits)

Data Rate: 9600 Bit's

Data format
1 startbit, 8 data bits and 1 stopbit. If the data transmission stops, the TXD-signal will be logic "high". (By using the RS 232C logic "high" is between -3V and -25V


amplification
of the measured
value
S3
keyboard
(only Graphic Commander)
Adjustment of
zero point and
amplification
for the X-direction
Adjustment of
zero point and
amplification
for the Y-direction
A/D converter
coordinate
(digital)
ZOOM keys
(only Bitmap)
pen
starting signal
X_2
Y_2
activ area
Y_1
micro computer
terminal
interface
X_1
S1
S2
U_b
+
-


pen on the tablet
no
yes
measurement of the X-coordinate and electrodes switching
measurment of the Y-coordinate and electrodes switching
coordinates valid ?
no
yes
sensor contact
no
yes
set sensor bit in the status byte
Data preparation
data output

Keyboard code table

Shift lock(alphalock): toggled on and off by ALPHALOCK key. When on, Normal and SHIFT codes are swapped for the 26 letter keys.

Automatic key repeat : initial delay of approx. 1 sec, then .. repeats per second.If REP key is pressed, delay is removed and ..repeats per second

Break function: activated by pressing CTRL/ESC

Notes : **up arrow, down arrow, left arrow, right arrow,** are standard cursor control arrow symbols.
Sharp, natural, flat, are musical accidental symbols.
CTRL + SHIFT gives same code as **CTRL.**

Pos.	Name	repeat	Normal	SHIFT	CTRL
A01	REPEAT				
A02	[{	*	5B	7B	1B
A03	] }	*	5D	7D	1D
A04-07	unused				
A08	space	*	20	20	20
A09-12	unused				
A13	ADD (sharp)	*	0E	CE	C6
A14	SUB (flat)	*	0F	CF	C7
A15	SET (natural)	*	19	D9	D1

Pos.	Name	repeat	Normal	SHIFT	CTRL
B01	SHIFT				
B02	\ |	*	5C	7C	1C
B03	Z	*	7A	5A	1A
B04	X	*	7B	5B	18
B05	C	*	63	43	03
B06	V	*	76	56	16
B07	B	*	62	42	02
B08	N	*	6E	4E	0E
B09	M	*	6D	4D	0D
B10	, <	*	2C	3C	BC
B11	. >	*	2E	3E	BE
B12	/ ?	*	2F	3F	BF
B13	SHIFT				
B14	unused				
B15	RUB OUT	*	7F	7F	7F

Pos.	Name	repeat	Normal	SHIFT	CTRL
C01	CTRL				
C02	ALPHALOCK				
C03	A	*	61	41	01
C04	S	*	73	53	13
C05	D	*	64	44	04
C06	F	*	66	46	06
C07	G	*	67	47	07
C08	H	*	68	48	08
C09	J	*	6A	4A	0A
C10	K	*	6B	4B	0B
C11	L	*	6C	4C	0C
C12	; +	*	3B	2B	BB
C13	: *	*	3A	2A	BA
C14	^AA~	*	5E	7E	1E
C15	RETURN	*	0D	0D	0D

Pos.	Name	repeat	Normal	SHIFT	CTRL
D01	ESC	*	1B	1B	BREAK
D02	TAB	*	09	C9	C1
D03	Q	*	71	51	11
D04	W	*	77	57	17
D05	E	*	65	45	05
D06	R	*	72	52	12
D07	T	*	74	54	14
D08	Y	*	79	59	19
D09	U	*	75	55	15
D10	I	*	69	49	09
D11	O	*	6F	4F	0F
D12	P	*	70	50	10
D13	@ ‘	*	40	60	00
D14	(up arrow)	*	1C	DC	D4
D15	(down arrow)	*	1D	DD	D5
D16	CLEAR	*	0C	CC	C4

Pos.	Name		repeat	Normal	SHIFT	CTRL
E01			*	5F	5F	1F
E02	1	!	*	31	21	B1
E03	2	"	*	32	22	B2
E04	3	#	*	33	23	B3
E05	4	$	*	34	24	B4
E06	5	%	*	35	25	B5
E07	6	&	*	36	26	B6
E08	7	'	*	37	27	B7
E09	8	(	*	38	28	B8
E10	9	)	*	39	29	B9
E11	0		*	30	30	B0
E12	-	=	*	2D	3D	BD
E13	(left arrow)		*	1F	DF	D7
E14	HOME		*	18	D8	D0
E15	(right arrow)		*	1E	DE	D6

Pos.	Name	repeat	Normal	SHIFT	CTRL
G01	F1	*	81	91	A1
G02	F2	*	82	92	A2
G03	F3	*	83	93	A3
G04	F4	*	84	94	A4
G05	F5	*	85	95	A5
G06	F6	*	86	96	A6
G07	F7	*	87	97	A7
G08	F8	*	88	98	A8
G09	F9	*	89	99	A9
G10	F10	*	8A	9A	AA
G11	F11	*	8B	9B	AB
G12	F12	*	8C	9C	AC
G13	F13	*	8D	9D	AD
G14	F14	*	8E	9E	AE
G15	F15	*	8F	9F	AF

Music Keyboard 8

Contents

Trouble shooting

The CMI has provision for one Master keyboard and an optional Slave keyboard which operates in parallel with the Master. The CMI mainframe has only one master keyboard input port, to which is connected the Master keyboard. The Slave keyboard, Alpha-numeric keyboard, and other attachments such as pedal controls, all connect to the Master keyboard. The latter contains an intelligent communications interface which monitors all attached devices and routes information from them through the single channel to the CMI. Other devices play into the MIDI sockets on the rear panel.

In addition to the piano type music keyboard, the Master keyboard provides two switch controls, as well as three rotary pot and two rotary wheel analogue controls. The switches (one momentary on, the other on/off) are fitted with lamp indicators whose purpose may be defined by the user by means of the CMI system software. One of the wheels has spring return, while the other wheel is unsprung. A 12 character LED alpha-numeric display and 16 switch keypad constitutes a simple user interface to the mainframe so that during a live performance, operations such as loading voices may be performed directly from the Master keyboard.

The Slave keyboard serves only as an extra music keyboard and contains none of the extra facilities of the Master keyboard.

Related Documents: The following drawings are either referred to directly in this manual or will be of use in servicing the CMI music keyboards -

Exploded diagrams	DMC004 Master Keyboard DMC004B Master Keyboard with cover DMC015 Keyboard switches subassembly DMC005 Slave Keyboard
Drawing Schematic Diagrams	DMC004C Bottom panel screw positions MC004-01 Master Keyboard wiring CMI10-01 Master controller to CMI10-04 CMI11-01 Switch module CMI12-01 Display/keypad CMI14 Slave interface module

Operating Principles

Control over all keyboard functions is centralised upon the CMI-10 Keyboard Controller which is located within the Master Keyboard. Keyboard scanning, of both master and slave keyboards, is accomplished by analogue multiplexing of the voltages on all key switches. The key switch mechanism consists of two brass buss bars running the full length of the keyboard which are supplied with +5 and -5 volts, and a delicate spring contact on each key which is allowed to move between the two buss bars as the key is pressed. By measuring the time it takes the spring contact voltage to change from -5V to +5V, the velocity with which a key is pressed may be calculated.

The analogue multiplexing is performed by the CMI-11 switch modules, each of which has provision for 24 or 25 spring contacts. Each module provides one analogue output which is the state of the contact currently addressed by the select lines from the controller, and each keyboard contains three modules. Six analogue comparators (three for the master and three for the slave) on the master controller receive these analogue signals and determine the state of the currently addressed key.

The user keypad and off/on switches are scanned in the same way although the multiplexed states are read directly as a digital signal.

The wipers of the five rotary controls on the master keyboard and three plug-in pedal pots are similarly multiplexed and fed to a single analogue to digital converter on the master keyboard controller. A change detected in any analogue level read by the converter is reported to the CMI provided that change is greater than 4 digital levels (which translates to a change of 2 in the MIDI output frame). The tolerance of the pitchbend controller under MIDI is set by a 6-pole DIL switch at power-up, but is only used when the pitchbend wheel changes direction.

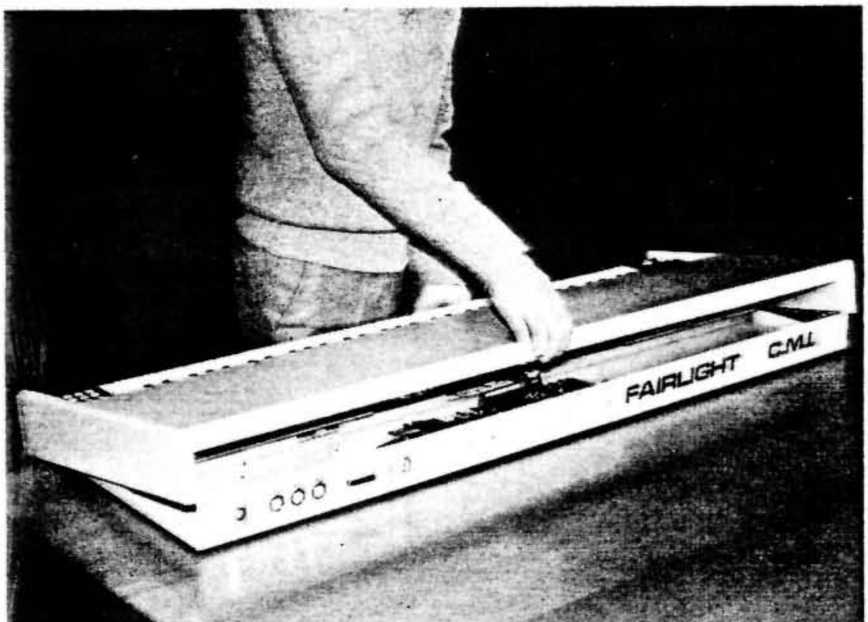
All information reflecting the state of the master and slave keyboards, and attached pedal controls are sent to the CMI via a serial communications channel in MIDI format. Characters received from the alpha-numeric keyboard are sent to the CMI through a serial communications channel at 9600 baud. User information received from the CMI through the same link is displayed on the LED display. The display modules accept ASCII characters directly from the keyboard controller.

Master Keyboard Disassembly

Removal of Wooden cover.
(Refer to drawings DMC-004C and DMC-004B)

1) Switch off CMI power and remove all cable connections to the keyboard.
2) Place keyboard upside-down on a soft surface.
3) Remove the six screws marked "A" and the five screws marked "B" on the drawing DMC-004C from the bottom panel of the keyboard. Do not remove any screws other than these from the bottom panel at this stage.
4) Return the keyboard right way up and remove the five back panel screws attaching the wooden cover to the panel, marked "C" on DMC-004C.
5) Lift the cover from the rear about 5 cm. then slide the cover forward while continuing to raise the rear as illustrated below.

With the cover off, the CMI-10 Keyboard Controller circuit module may now be observed, along with the wiring from the rear panel connections to the module. To remove the module, follow steps 6-9.



Removal of CMI-10 Keyboard Controller
(Refer to drawing DMC-004)

6) Remove all cable connections to the CMI-10 module.
7) Unscrew three nuts and bolts attaching the CMI-10's heatsink to the back panel.
8) Six plastic standoffs secure the module to the base of the keyboard. With a small screwdriver, press the catch of each standoff while gently prising the module up.
9) Lift the module off the standoffs.

Access to Keyboard Switch Mechanism
(Refer to drawings DMC-004C and DMC-015)

10) Slide the keyboard forward so the five screws marked "D" in drawing DMC004C may be accessed from underneath. Remove these screws to release the retaining strip which secures the keyboard assembly to the bottom panel.
11) The entire key assembly may now be swung up on its own hinges by lifting from underneath the keys. Support the assembly from behind on a piece of soft foam to avoid scratching the keys.

At this point the three CMI-11 switch modules may be viewed with the spring switch contacts gently stretched across the brass -5V buss bar and engaged in the plastic "keyhole grips" extending from underneath each key. Each grip has two keyholes: the spring contact should always be engaged with the lower one (closest to the underside of the key).

Removal of CMI-11 switch modules
(Refer to drawing DMC-015)

The following steps should be followed for each module to be removed:

12) Remove the 10-way cable plug from its socket.

CAUTION: This cable should never be plugged or unplugged with the keyboard power applied or damage will result to the switch module circuitry.

13) Using tweezers or fine pliers, gently grip each spring switch contact and stretch it just enough to release it from its keyhole catch. Tuck it down underneath the lower brass buss supply bar (-5V).
14) Use a 6BA nut driver to remove the 9 nuts and star washers securing the switch module to the underside of the key assembly.
15) Unscrew the 3 screws which pass through the buss bar support blocks to the underside of the key assembly.
16) Lift the module off its supports.

Removal of Control Panel and Display/Keypad
(Refer to drawing DMC-004)

17) Slide the keyboard forward again as in step 10, and remove the four screws numbered 31 and 32 on the left in drawing DMC004 for the control panel, and/or the corresponding screws on the right for the display/keypad.
18) Lower the keyboard and remove the 20-way flat cable from the display/keypad or release from its cable clips the 20-way ribbon cable leading from the CMI-10 module to the control panel. This cable is attached to the control panel.
19) Lift the desired assembly out.

Master Keyboard Reassembly
Reassembly of the Master keyboard is essentially a matter of reversing the procedures of Section 2.1. Care should be exercised while replacing the CMI-11 switch modules not to damage the delicate spring switch contacts. Tighten the nine nuts and three buss bar support screws evenly to ensure the module is not warped or distorted in any way and that the buss bars are not bent.

Slave Keyboard Disassembly And Reassembly
To remove the wooden cover and the CMI-11 switch modules from a slave keyboard, follow the same procedures as specified for the master keyboard on pages 8.4 and 8.5 respectively.

Removal of CMI-14 Slave Interface
(Refer to drawing DMC-005)

1) With CMI power off, remove the flat cable connecting the master and slave keyboards, if not already done.

CAUTION: Always turn off CMI power to the master keyboard before connecting or disconnecting the external cable between the master and slave. Omission to do this will cause damage to the switch modules in the slave keyboard.

2) The CMI-14 module is item 7 on DMC-005. Release the 25-way flat cable leading to the CMI-11 switch modules (item 8).
   The same caution applies to this cable as to the external cable.
3) Remove the three screws marked 13 which secure the module to the back panel of the slave keyboard.
   Reassembly of the slave keyboard is the reverse of the disassembly procedures.

Failure Of Master Keyboard To Power-Up

Successful power-on sequence of the Keyboard Controller is indicated by the control panel switch lights flashing on for approximately 1 second, off for another second, then on again. A "-SERIES III-" message is then written to the keypad display. If this does not occur and the CMI does not respond when the keyboard is played or the keypad operated, try to run the built-in diagnostic program (refer to pg. 8.18). If there is still no response, follow the procedure below.

1) Check that all power supplies (+10V, +20V and -20V) are present on the Music Keyboard cable from the CMI. Refer to drawing MC004-01. If not, check CMI fuses, the Cannon connector on the back panel of the keyboard, and the cable itself.
2) Remove the cover of the keyboard according to page 8.4.
3) Ensure all cables are firmly connected and that the correct power supplies are present on the six pin Utilux connector to the CMI-10 Keyboard Controller. If not, look for the faulty connection between the back panel sockets and the CMI-10, referring to drawing MC004-01.
4) Check that both DIL switches on the CMI-10 are set correctly. SW3 (4-way) should have switches 2 and 3 only closed, SW4 (6-way) should have switches 1 and 2 only off. Refer to pages 8.9 and 8.11.
5) Verify the voltages on each power supply regulator output on the CMI-10. Refer to page 8.14.
6) Check that the power-on restart circuitry holds the processor in reset for approximately 0.4 secs. Refer to section page 8.9
7) Check that the processor crystal is operating and that the processor ø2 output signal is present.
8) Check that the processor is not receiving spurious interrupts due to a faulty SW3. Refer page 8.9.
9) Establish whether the controller is running its program by examining the VMA, data and address lines, and checking peripherals which are accessed in the processor idle loop (refer to page 8.18). If it is, then the controller is powering up but a major I/O problem is preventing all normal indications of this. Otherwise, a fault in the processor itself, the address decoding system, the ROMs or RAM is causing the controller to crash. In both cases, carefully check each of the functions described in page 8.9 to isolate the fault.

Individual Key Failure (Master and Slave)

The failure of a single key to operate will usually be caused by a mechanical problem in the spring switch contact mechanism. Remove the cover of the keyboard according to page 8.4 and hinge the key assembly up as described on page 8.5.

Common causes of failure are damaged, loose or dirty spring contacts, or inadequate contact between the spring and the brass buss bars.

Failure Of Groups Of Keys (Master and Slave)

If all the 24 or 25 keys scanned by a particular switch module fail to operate then the fault lies either in that module (check the voltages on both buss bars) or in the path from it to the analogue key data multiplexer in the Keyboard Controller (incuding the cable). The source of such a fault may be isolated by swapping around the flat cable connectors to the switch modules.

Failure of certain keys belonging to each module is most likely to be caused by incorrect scanning addresses arriving at the switch module: either a cable fault or an I/O problem on the keyboard controller. In this case it is unlikely that the keypad or display will work either.

If no such module-related pattern to the faulty keys exists, then the problem is mechanical. Check that all spring contacts bend across the -5V buss bar by approximately 20 degrees from the horizontal when the keys are released and across the +5V bar by the same angle (in the opposite direction) when the keys are depressed. A tension spring in the back of each key returns it to the original position when it is released.

Slave Keyboard Malfunctions

Failure of groups of keys or individual keys on the slave keyboard can be diagnosed following the same guidelines as for the master keyboard. However two additional possible sources of faults exist: the cable from the master keyboard to the slave, and the CMI-14 slave interface. Since the slave scan address lines are the same as the master scan address lines, faults in the slave keyboard which corrupt those lines can cause the master to malfunction. Page 8.27 describes the use of the 4-pole DIL switch on the CMI-14 to disable individual switch module outputs when isolating slave keyboard faults. Ensure that all switches are open to enable the full keyboard velocity sensing prior to reassembling the slave.

CAUTION: Always turn off CMI power to the master keyboard before connecting or disconnecting the external cable between the master and slave. Omission to do this will cause damage to the switch modules in the slave keyboard.

The function of the CMI-10 Master Keyboard Controller card is to execute all keyboard facilities of the CMI and communicate the status of those facilities through a single cable (two serial channels) to the central processor. The facilities are -

Master keyboard scanning (with CMI-11 multiplexer).
Slave keyboard scanning (with CMI-14 slave interface and CMI-11 multiplexer).
Data link to CMI for the alpha-numeric keyboard.
Master keyboard keypad.
Keypad display of information from CMI.
Three rotary pots.
Two rotary wheel pots.
Two on/off switches.
Three pedal controls with switches.

This section describes the operation of the CMI-10 board.

MPU,DECODING,RAM AND RESTART.

(Refer to drawing CMI10-01)

Microprocessor Unit

The central driver of the Keyboard Controller is the 6802 microprocessor unit (MPU) at location E567 which is activated by a 4MHz crystal. At power-up the MPU reset line is held low for approximately 0.4 seconds at which time it is released to begin execution. It is important that this restart time is less than the CMI's Central Processor restart interval to ensure that no characters sent to the Keyboard Controller are lost. The MPU may also reset manually by depressing SW1 (nearer the heatsink). This switch is debounced through the pair of open-collector NAND gates D12.

While the restart line is held low, the MPU places FFFE (hex) on the address buss and its first operation is to fetch the restart vector from locations FFFE/F. Execution is then transferred to the initialization routines in ROM. Successful completion of this power up phase is indicated by the keyboard switch lamps switching on for about one second, off for another second, then on again. A "-SERIES III-" message is then written to the keypad display.

A 4-pole dual-in-line (DIL) switch, SW3, is used to select the source of Non-Maskable Interrupts to the MPU. This may be either from the manual switch SW2 or a clocked timing signal. The DIL switch functions as follows:

Switch	Effect if closed
1	Select BRCK signal from Baud rate gen. as timing reference.
2	Select ø2 from MPU as timing reference.
3	Select SW2 as NMI
4	Select timing reference as NMI

Clearly, switches 1 and 2 are mutually exclusive and must not be closed simulataneously, as are switches 3 and 4. Before feeding to switch 4, the high frequency reference selected by switches 1 or 2 is divided by 512, 1024, 2048 or 4096 by the binary counter C5. This division ratio is determined by the p.c.b. link next to C5 (normally 2048). The divided reference (signal SCND) is used as a control line signal to the PIAs, in addition to optioning as an NMI source.

With "MIDIKBD" and "KEYDIAG" ROMs, switches 2 and 3 only should be closed. This selects SW2 as NMI source, and this will activate the diagnostic routines if present. The NMI vector is at FFFC/D. Switch 1 of the DIL switch is nearest the edge of the PCB with the heatsink.

The 6802 MPU contains 128 bytes of internal RAM. This is permanently enabled by tying the Ram Enable signal (pin 36) high.

Address Decoding

Selection of all ROMS, external RAM and peripheral devices is performed by four LS139 1-of-4 decoders in ICs E12 and E34. Addresses are decoded when both the ø2 and VMA (Valid Memory Address) signals from the MPU are high.

The address map of the Keyboard Controller is as follows:

Address (Hex)	Function
0 - 7F	Internal RAM. 23 bytes only used, for software variable storage.
80 - 83	Active key input/AD conv. input PIA (K34)
90 - 93	Key address output PIA (F34)
A0 - A1	Alpha-numeric keyboard comms. ACIA (C67)
B0 - B1	CMI communications ACIA (D67)
C0	Software readable switch
4000 - 43FF	External RAM #1 (L67, N67)
5000 - 53FF	External RAM #2 (K67, M67, not normally installed)
9000 - 97FF	ROM #1 (J67, not normally installed)
A000 - A7FF	ROM #2 (HI67, not normally installed)
B000 - B7FF	ROM #3 (G67, "KEYDIAG")
F800 - FFFF	ROM #4 (F67, "MIDIKBD")

Software Readable Switch

The six-pole dual-in-line (DIL) switch SW4 selects a number of software functions. Bit 5 selects MIDI or Series I/IIX Fairlight mode. If bit 5 is off, the keyboard will behave like a Series I/IIX Fairlight keyboard and will communicate with the CMI only via RS-232 at 9600 baud. However if bit 5 is on, key depressions and control changes will be sent to the CMI in MIDI format at 31.25k baud. Keypad depressions are always sent via RS-232 regardless of bit 5. When connected to the Series III CMI, bit 5 should be on. When bit 6 is off, the two rotary wheels are ignored. At power-up, bits 1-4 are read, and this 4-bit number determines the sensitivity of the pitchbend control (wheel #1) under MIDI. When the pitchbend wheel changes direction, no more pitchbend data will be sent to the CMI until the ADC detects a change in digital levels of more than this sensitivity value. Normally sensitivity is set to 3 digital levels so switches 1 and 2 only should be off.

The switch is read through buffer N8 whose inputs are pulled high, unless grounded by a closed switch. Thus a binary '1' corresponds to an open switch.

External RAM

Provision is made on the CMI-10 p.c.b. for 2K of static RAM but normally only 1K is installed: 2114s L67 and N67. Each chip contains 1K x 4 bits storage. The upper nybble is stored in L67, and the lower nybble in N67.

ROMS and Peripherals

(Refer to Drawing CMI10-02)

ROMS

Provision is made on the CMI-10 printed circuit board for four 2516 ROMs. Normally only two of these are installed: "MIDIKBD" at F67, and "KEYDIAG" at G67. The first ROM contains the MIDI keyboard driver routines and is normally the only ROM in use, the second provides diagnostic routines.

Serial Communications ACIAs

RS-232 data from the Alpha-numeric keyboard is received, and MIDI sent, through the 6850 Asynchronous Communications Interface Adaptor (ACIA) at C67. MIDI data is driven as a current loop by LS03 D1,2 through 220R resistors R29 and R30. Series I/IIX keyboards without MIDI use the output side of C6,7 for RS-232 output to the Alpha-numeric keyboard instead of MIDI. RS-232 communication to and from the CMI utilises the 6850 ACIA at D6,7.

The baud rate for RS-232 channels is derived from the baud rate generator at B12 driven by a 1.8432MHz crystal and a PCB link at C12 normally selects 9600 baud operation (from pin 1 of B12). The baud rate generator also provides the BRCK signal, normally linked to 1200 baud at B45. MIDI communication with the CMI occurs at 31.25k baud through C67. However if bit 5 of SW4 is off, the keyboard will behave like an early keyboard and communicate to the CMI at 9600 baud through D67 only. MIDI should be selected when using a Series III CMI. The 31.25k baud signal is derived from ø2 divided by the counter at C5. Note that the timing signals are 16 times the baud rate.

Both ACIAs are normally linked via LK1 and LK2 to the common interrupt request (IRQ) buss signal, and generate interrupts whenever characters are sent or received.

Peripheral Interface Adapters (PIAs)

Two PIAs are used, each containing two 8-bit parallel I/O ports and four control outputs/IRQ input lines. The PIAs are configured during initialization and used as follows:

PIA F34

I/O port A PAO - PA1	Peripheral address outputs. Buffered through G23 to address to provide: CMI-11 switch module addresses CMI-12 keypad mutiplexer addresses LED display module data Data inputs to flip-flops (G4) which switch control button lamps. Analogue control input multiplexer addresses.
CA1	Scan Not Done (SCND) timing flag input
CA2	Strobe output to update lamp flip-flops
I/O port B PB0 - PB1 PB2 - PB7	LED display digit select lines LED display all-segments-on (CU) and module select (CS) signals.
CB1	Input flag from keypad multiplexer. Does not generate IRQs.
CB2	Strobe output to update a LED display ($\overline{DWS}$)

PIA K34

I/O port A PA0 - PA5	Inputs from music key threshold comparators
PA6	Input from control switch multiplexer enabled by BKA7
PA7	Input from keypad multiplexer, also enabled by BKA7
CA1	Inverted timing reference input. Does not generate IRQs
CA2	Threshold select output
I/O port B PB0 - PB7	Data inputs from A/D converter (ADC)
CB1	$\overline{DR}$ (Data Ready) flag from ADC
CB2	B/$\overline{C}$ (Begin Conversion) strobe to ADC

Power Supplies

The Keyboard Controller receives +20V, -20V and +10V from the CMI through a 6-pin Utilux connector. Six on-board regulators (see drwg. CMI10-04) are used to generate three independant +5V supplies, in addition to +12V, -12V and -5V supplies. These power the Controller itself plus the keypad display, analogue controls and switches.

The supply designated "+5V" powers all circuitry on drawings CMI-10-01 and CMI-10-02 except the ROMs, which are powered separately from "+RV". The analogue multiplexers, A/D converter and RS-232 drivers on CMI-10-03 and CMI-10-04 receive power from "+XV" and where necessary, the -5V supply.

"+XV" and "-5V" leave the Controller board via SO1 to power the CMI-11 keyboard switch multiplexers, and the keypad display.

"+XV", "-5V", "+12", "-12" and "+20" leave via SO5 to power lights, switches and pot controls on the CMI-319 Analogue Control Module.

"+XV", "-5V", and "+20V" leave via SO2 if that socket is used (see the end of page 8.15)

Threshold Detection

MD1-3 and SD1-3 are the multiplexed signals representing the position of music keys addressed by the three master keyboard CMI-11 modules and the slave keyboard interface CMI-14, respectively. These signals are compared by the six MLM311s to a known threshold to determine when a key begins to be pressed, and when it is fully depressed.

The THLD signal from PIA K34 sets up one of two thresholds through the 741SC level shifter. If THLD is low, a -2.7V threshold is applied to the comparators. With THLD high, the threshold is +2.3V.

Initially, THLD is low. An unpressed key rests against the -5V buss bar so the corresponding comparator output will be high. When the key is first depressed and the spring contact leaves the -5V buss bar, the output of the module when that key is selected is pulled to just below zero volts by a 10k resistor to ground on the switch module and a 100k resistor to -5V on each comparator input. This causes the comparator to change state to a low. The change is read from the PIA whereupon THLD is switched high to select the +2.3V threshold, setting the comparator high again. It will return low when the key reaches the +5V buss bar at its full depression. The time taken between the two falling edges of the comparator output is noted by the MPU, and this mechanism forms the basis of the velocity sensitive keyboard.

The key continues to be compared to the +2.3V threshold until its release is detected.

Control Signal Multiplexors and A/D Convertor

User control signals enter the Keyboard Controller from several possible sources: two control panel switches, three control panel rotary pots, two control panel wheel pots, three pedal switches and three pedal pots. The switch controls are analogue multiplexed by H3 and read directly as KD6 when gated by a high level on BKA7.

The analogue controls (rotary, wheel and pedal pots) are multiplexed by I3, buffered by I4 (741SC), and fed to the AD570 A/D converter at J4. The low frequency signals used do not require a sample and hold. The converter is strobed to begin a conversion by the B/$\overline{C}$ signal from the CB2 output of PIA K34 and flags the end of conversion to CB1 of the same PIA.

The sensitivity of the pitchbend control may be set by DIL switch SW4. Refer to page 8.11 for further details.

RS-232 Interface

ICs A5 and A6 are the RS-232 drivers for the two ACIAs described on page 8.12.

Lamp driver

The control panel lamps are supplied with 20V and switched on when the MC75452 driver at J2 pulls the appropriate line to ground. The driver is activated by signals LP1 and LP2 latched from PIA F34.

Connections

The Keyboard Controller has five external connections as detailed below. Note that SO2 and SO5 are wired differently between Revs 6, and 5 and that SO5 does not exist on earlier revisions. The different cabling configurations are explained after the connection lists.

SO1 - 50-Way flat cable connector.

Pins 1-5	Master switch module 1 scan address
6	N/C
7	-5V to Master switch module 1
8	"+XV" 5V to module 1
9	Ground to module 1
10	MD1 module 1 multiplexed output
11-20	Master switch module 2 connections as for 1
21-30	Master switch module 3 connections as for 1
31-37	Scan address to keypad and data lines to LED display
38	All segments on, display module 0 (CU)
39	Module select, module 0 (CS)
40-41	CU and CS lines, display module 1
42-43	CU and CS lines, display module 2
44-45	LED display digit select
46	Digit write strobe
47	Keypad multiplexed output
48	$\overline{BKA3}$, selects keypad multiplexer 2
49	Ground to display/keypad
50	"+XV" +5V to display/keypad

SO2 - 10-way rainbow cable connector to pre-pitchwheel analogue controls.

Pin 1	Pulled low to light lamp 2
2	Pulled low to light lamp 1
3	State of switch 2
4	State of switch 1
5	Output of pot 3
6	+20V unregulated
7	-5V
8	+5V
9	Output of pot 2
10	Output of pot 1

SO3 - 26-Way rainbow cable connector

Pin 1	Pedal 1 pot wiper
2	Pedal 1 switch
3	Pedal 2 pot wiper
4	Pedal 2 switch
5	Pedal 3 pot wiper
6	Pedal 3 switch
7-11	Slave keyboard scan address
12	Slave keyboard ground
13-15	Slave switch module outputs
16	RTS flag to alpha-numeric keyboard
17	CTS flag to A/N keyboard
18	A/N keyboard ground
19	Data to A/N keyboard (pre-MIDI only)
20	Data from A/N keyboard
21	Ground
22	MIDI+ (pre-MIDI: Flag from CMI)
23	MIDI- (pre-MIDI: Flag to CMI)
24	Ground
25	Data from CMI
26	Data to CMI

SO4 - 6-Way Utilux Connector

Pin 1	+10V return
2	+10V
3	+20V
4	-20V
5	Ground
6	+/-20V return

SO5 - Rev 4 and below: not installed
Rev 5: 10-way flat cable connector
Rev 6: 20-Way flat cable connector

Pin 1	Ground
3	+12V
4	Output of wheel 2
6	Output of wheel 1 (pitchbend)
7	-12V
9	-5V
10	Unused

Pins 11-20	Only on Rev 6+
11	Pulled low to light lamp 2
12	Pulled low to light lamp 1
13	State of switch 2
14	State of switch 1
15	Output of pot 3
16	+20V unregulated
17	-5V
18	+5V
19	Output of pot 2
20	Output of pot 1

Cable configurations for analogue controls.

The above lists show that the 10-way connector at SO2 is wired in parallel with the upper 10 pins of the 20-way connector at SO5. This is to allow a single 20-way cable connection from SO5 to CMI-319 in Series III keyboards but still allow Rev 6 CMI-10s to be used as replacements in Series I/IIX keyboards, with a 10-way cable from SO2 to the analogue controls.

SO2 is not used if a Rev 6+ CMI-10 is installed in a Series III keyboard.

If a Rev. 5 CMI-10 is installed in a Series III keyboard, 10-way cables go to both SO2 and SO5, from the 20-way connector on the CMI-319 module.

Rev 4 and earlier CMI-10s cannot be used in Series III keyboards with pitch/modulation wheels.

Standard Diagnostic Routines

Built into the keyboard ROM "KEYDIAG", are a set of diagnostic routines designed to discover and isolate hardware faults that are not so serious that they prevent the 6802 processor from operating. These routines are capable of surviving faults which stop the normal driver software.

Although invisible during normal operation, they can usually be activated and the faults confirmed without opening the keyboard or requiring the use of a CMI except to provide keyboard power. The only tool needed is a jumper plug for the 9-pin D-socket labelled "TO CMI" on the back plate of the keyboard. This plug should have pin 6 connected to pin 9. If a fault is detected, you will have to open the keyboard case and locate the fault yourself, however the diagnostic routines can give you a good idea of where the failure is located.

By following this step-by-step guide, you can thoroughly test the music keyboard.

Starting the Diagnostics.

Disconnect the power to the keyboard. Depress "*" and "D" on the keypad and keep them pressed. Now connect the power to the keyboard. Both lamps should come on, go off, and come on again. The LED display should display "KDIAG3MIDIK9" or a similar message. This tells you the names of the two ROMs installed, in this case "KEYDIAG3" and "MIDIKBD9". Obviously, the ROMs may have been updated since this document was written. You should check to make sure that the latest ROMs are installed (if "DIAGNOSTICS:" appeared on the screen, then you have a pair of ROMs that are capable of crashing the CMI by sending spurious MIDI frames: definitely replace these). If all is well, go to RAM test pg. 8.20. Otherwise:

a) The lamps did not come on and the display did not display a message:

1) Check that all power supplies (+10V, +20V and -20V) are present on the Music Keyboard cable from the CMI. Refer to drawing MC004-01. If not, check CMI fuses, the Cannon connector on the back panel of the keyboard, and the cable itself.
2) Verify the voltages on each power supply regulator output on the CMI-10. Refer to page 8.14.
3) Check that the power-on reset lasts 0.4 seconds. Refer to page 8.9.
4) Check that the processor crystal is operating and that the processor ø2 clock signal is present.
5) Establish whether the program is running by examining the pins of the 6802 with a logic probe or CRO.
6) If the program is running, then the fault probably lies in the PIA's or cables connecting the circuit boards within the keyboard.
7) PIA test, step 2 pg. 8.20 details a method for activating the diagnostics which does not depend upon the PIA's.

b) One or both of the lamps did not come on but a message was displayed:

1) Check the lamps
2) Check the cable to the analogue controller board.
3) Check the driver at J2. Refer to drawing MC004-03.

c) Both lamps came on, turned off and came on again, but no message or a garbled message was displayed:

1) Check the cable to the keypad and display.
2) The PIA's may not be working properly (but the PIA at F3,4 is partially working since the lamps work).
3) The display may be faulty.
4) A program is running, but go to step 4.4.2 anyway.

d) The message "-SERIES III-" appears:

1) Check that "KEYDIAG" is present in socket G6,7.
2) The ROM "KEYDIAG" may be faulty.
3) The addressing to G6,7 may be faulty.
4) You may have released either "*" or "D", or depressed another key when power was applied.
5) The keypad or it's cable may be faulty.
6) The PIA at K3,4 may be faulty.
7) Go to step Alternative Startup Procedure below anyway.

e) Both lamps came on, turned off, but only the left hand lamp came on again. Nothing was displayed:

1) You have just witnessed a lamp blowing!
2) The internal RAM on the 6802 is faulty. You must replace the processor at E5,6,7

Alternative Startup Procedure.

Open the case of the keyboard *(refer to page 8.4)*. Press SW2 at C8 to produce an NMI. This will always activate diagnostics if "KEYDIAG" is present. Failure of any sign of program operation to occur is due to faulty PIA's, timing problems or a faulty processor. Other problems are the same as for (1), except that the keypad and PIA at K3,4 are not used. If the program is running and the ACIA at D6,7 is working, then a short transmitted message should be detectable on the jumper plug attached to the "TO CMI" port about 18 seconds after the NMI was pressed.

RAM Test.

The display will change to "TESTING 2114". The 2114 ram chips at L6,7 & N6,7 are now being tested, and this will take about 11 seconds. "OK" should then flash onto the screen. If instead:

a) "R1E=xxxxxxxx" appears, where xxxxxxxx is a hexadecimal number, then the 2114 ram chips have failed that many times. This number is the total number of failures since the diagnostics were started. Since there are $400 ram locations, and each location is tested $100 times, the maximum number of errors detectable in each execution of the ram test routine is $40000.

PIA Test.

The display will change to "TESTING PIA". In about half a second, "OK" should appear. If instead:

a) The left hand lamp turns off or "PIA1ER" or "PIA2ER" appears - a problem was detected in one of the PIA's. PIA #1 is at F3,4 (look for overloaded outputs) and PIA #2 is at K3,4 (it has to be very dead to fail this test)

1) PIA #1 is used for device selection and display. PIA #2 is used for keyboard & keypad addressing, and A/D conversions. If you have come this far and received messages on the LED display, PIA #1 is working, so suspect wiring or contacts instead.
2) It is possible for malfunctioning PIA's to pass this test.

ACIA Test.

The display should change to "TESTING ACIA". In about half a second "OK" should appear. If instead:

a) "AC2RER" appears, then a garbled message was received by the ACIA at D6,7. The program will continue after a few seconds.
b) "AC2TER" appears, then no message or an incorrect message was received at D6,7.
c) nothing appears, then the program has probably hung due to the IRQ line to the 6802 being pulled permanently low.

The ACIA at C6,7 is not tested by this program as it is used to generate MIDI, which operates at a different baud rate from all other communication channels. This should be tested by playing some notes using the normal keyboard driver.

Check the jumper plug, the 9-pin D sockets on the keyboard back panel, and the wires to these sockets before suspecting the ACIA device.

Main Event Loop.

The screen should now show "GO" and the program will be in an endless loop. If any change is detected in the state of any key, switch, pot or pedal then this change will be displayed on the screen as follows:

"MK zzz DN"	Key zzz is fully depressed
"MK zzz UP"	Key zzz has been released
"MK zzz MD"	Key zzz is half depressed
"SW yy DN"	Switch #yy on the analogue controller board is fully depressed
"SW yy UP"	Switch #yy on the analogue controller board has been released
"PS yy DN"	Pedal switch #yy has been pressed
"PS yy UP"	Pedal switch #yy has been released
"DSW xx"	The value of the DIP switch is $xx
"KP w DN"	"w" has been pressed on the keypad
"KP w UP"	"w" has been released on the keypad
"POT yy xx"	The value of rotary pot #yy is now $xx
"PDL yy xx"	The value of pedal #yy is now $xx
"PB xx"	The value of the pitch bend is now $xx
"W2 xx"	The value of wheel 2 is now $xx

where:

w	is a letter available on the keypad,ie 0,1,2,3,4,5,6,7,8,9,A,B,C,D,* or #
xx	is a two digit hexadecimal number
yy	is a number, ie 02, representing the number of a particular device if more than one may be connected at once.
zzz	is the name of a musical note. The first digit represents the number of the octave. The last two digits are the name of the note, ie C# or G. The lowest note on the keyboard is 1F and the highest is 7F. All notes from C to the next highest B have the same octave number.

If the ADC fails to read a value, the message "ADC E=xxxx" will be displayed briefly, every time the program goes through this program loop. xxxx is a hexadecimal value representing the total number of ADC failures detected so far. ADC errors are usually due to problems with the -20V power supply from the CMI, or the -5V and -20V regulators on CMI-10. Fuse #7 in the base of the CMI is attached to the -20V keyboard supply.

Analogue Controller Testing

At this stage you should check that the pots, pedals, wheel and pitchbend controls work properly. They should go from $00 to $FF with $80 being the central value. This display has a window of 2, so you should strive for values accurate to +/-1. Check also that turning any of the controls beyond $FF or $00 does not result in phantom turning of some other control. This problem is a result of overloading the analogue multiplexers, and can be partially cured by adjusting the trim pots on the underside of the analogue controller box at the left hand end of the keyboard.

If the keyboard case is open, and you suspect that the DIL software switch may not be working, then toggle one of the switches in this DIL switch. The default value of the DIL switches is $03, which corresponds to switches 1 and 2 only being on. Remember that the program reports only what the switches have been changed to, not what they were originally. Alternatively, press "*" then "2". The display will report the current value of the DIL switch, and then continue. This command is discussed in more detail below.

Commands

One key that has special significance is "*". This is the command key. Pressing it results in the message "COMND:" being displayed. Pressing another key will allow you to select from the following alternatives:

"A" One time test of the <u>2114</u> rams

"B" One time test of the <u>PIA's</u>. Not all problems with the PIA's can be detected.

"C" One time test of the <u>CMI</u> ACIA.

"2" The current setting of the 6-pole DIL switch at M8 will be displayed on the screen as a hexadecimal number. The default setting is $03. The value of switches 1 to 6 correspond to $01, $02, $04, $08, $10, and $20 respectively when they are in the off position.

"3" Perform tests A, B, C and calculate the ROM checksum continuously. If the message "ROM = xx" is displayed, then there is a fault in the ROM "KEYDIAG" which is probably due to an intermittent addressing problem. Such a problem would also cause the ROM checksum to be unstable, and the software will crash with similar regularity. Test 3 is a good soak test for the keyboard. While each test is in progress, a message "TESTING {device}" will be displayed. Successful completion of each test is indicated by "OK" flashing onto the screen. Failure will result in an error message, and a jump into the error handler. If more than 15 seconds goes by without the display changing, then the program has hung.

"1" Continue after a pause of a few seconds when an error is detected. After this command has been executed, the error handler will continue the diagnostics after a pause of a few seconds. This command cannot be undone. It should not be executed before performing an unattended soak test as any error messages will be overwritten.

"#" A check of all keys will be performed by asking you to press every key on the keyboard from lowest to highest. "SCALE" will be displayed on the screen to indicate that the command has been recognised. The display will change to "PRESS 1F". When you have pressed and released this key (the lowest key on the keyboard) it will ask you for the next higher key. After all keys have been pressed, the display will return to "GO". If any key is missed, the display will continue to display that key until it is pressed. In order to avoid multiple key depressions, it is suggested that this test be performed using one finger.

"0" Jump into MIDI driver code. The keyboard will behave just like a regular keyboard and can be used to output MIDI to the CMI. If you wish to return to diagnostics, you should go to step (1).

"D" Return to the diagnostic loop that reports changes in the state of keys etc. This command is used to undo the effect of pressing "*".

Stopping a Continuous Test

To get out of a continuous test, simply turn the power off and on, or press NMI (SW2) or press RESET (SW1). NMI will always get you into diagnostics again, while "*" & "D" need to be pressed if the keyboard is RESET or powered up.

The Error Handler

The error handler is a subroutine designed to make sure that you have received each error message. It waits for all keys on the keypad to be released. Next, it waits for the keys "1", "4", "7" and "*" to be pressed simultaneously. After a wait of a couple of seconds, the program returns to where it left off. If you wish the program to continue after a pause of a couple of seconds without waiting for these key depressions then issue the command "*" & "1" before executing any continuous test.

Soak Tests

A thorough test of the keyboard should also include the following:

a) Turn the keyboard on and leave it for 15 minutes or more. If the message "GO" is still on the screen then there are probably no problems with dirty contacts. If a message such as "MK 6G# UP" is displayed, then this key may not have reliable contacts.

b) Execute the command "*" & "3" and leave it for several hours (days?). This should detect intermittent problems with RAM, ROM, PIA's and CMI ACIA.

c) Finally, <u>connect it to a CMI</u>. RESET the keyboard by turning the power off and on while none of the keypad keys are depressed. The keyboard should now be producing MIDI code whenever keys are hit. Verify this by playing a few notes through the CMI. This is extremely important as the MIDI ACIA cannot be tested by the diagnostic routines because it operates at a different speed from the two serial inputs.

Three Keyboard Switch Modules are installed in each master and slave keyboard used with a CMI. Each module provides a single signal out which represents the state (pressed, released, or in flight) of one of the 24 or 25 keys addressed by the multiplexer inputs. This section describes the operation of the CMI-11.

Keyboard Switch Module Operation
(Refer to drawing CMI-11-01)

Five key address bits are provided provided by the Keyboard Controller CMI-10 as inputs to the CMI-11. The lower three of these are bussed across three 4051 analogue multiplexers (ICs 2-4) so that each 4051 selects one of eight spring key contacts as its analogue input. Normally, a key rests against a -5V buss bar, but when fully depressed, it contacts a +5V buss bar. In between, it contacts neither.

The outputs of ICs 2-4 are fed to another multiplexer, IC1, whose select inputs are the upper two bits of the key address. Thus the output of IC1 may be any of the 24 key contacts accessed by ICs 2-4. It may alternatively be the 25th key contact which is fed directly to IC1 as a fourth analogue input.

Each CMI keyboard has a total of 49 keys so the 25th key is only used on the extreme right hand switch module. Provision is made on the switch module p.c.b. for a 10k resistor (R1) pulling to ground. This is to ensure that if the 25th key is not installed, it appears to the multiplexer as a key which is never pressed. However, the resistor must be removed if the 25th key is installed or the velocity sensing mechanism will not work on that key.

The output of IC1 is fed directly to the Keyboard Controller in a master keyboard or to the Slave Interface in a slave keyboard. Its unused inputs are grounded.

External Connections

SO1 - 10-Way flat cable

Pins 1-5	Key scan address inputs
6	N/C
7	-5V supply
8	+5V supply
9	Ground
10	Multiplexed analogue output

The Display and Keypad Module provides a simple user interface with the CMI from the master music keyboard. A 16-switch keypad is scanned by the Keyboard Controller for commands to be sent to the CMI and a 12 digit LED display receives simple messages from the CMI to the user. This section describes the operation of the CMI-12.

Display and Keypad Operation
(Refer to drawing CMI-12-01)

LED Display
The DL-1416 LED display modules, containing four digits each, accept 7 bit ASCII codes from the data lines to display the desired character. The key scan addresses are used as data inputs. Data is latched into the modules whose chip select line ($\overline{\text{CS}}$) is low on the falling edge of $\overline{\text{DWS}}$. The DA lines select which digit within the selected module(s) is written to. The $\overline{\text{CU}}$ line is a test enable line which causes every segment in each digit to light up.

Keypad
The keypad is simply an array of 16 momentary switches which connect to the common (+5V) line when pressed. Two 4051 1-of-8 analogue multiplexers scan the keypad. Their select and inhibit inputs are taken from the key scan address lines. Only enabling one multiplexer at a time allows the outputs to be wired together on the same KPAD signal.

External Connections

SO1 - 20-Way Ribbon cable connector

Pins 1-2	Digit select
3,5,7	Display module select
4,6,8	Display module test (all segments on)
10	Digit write strobe
9,18, 11-16	Key scan address and data to display modules
17	Keypad multiplexed output
19	Ground
20	"+XV" +5V supply

The Slave Keyboard Interface provides regulated power supplies to the CMI-11 switch modules in a slave keyboard and buffers the analogue outputs of the switch modules before feeding them to the master keyboard controller. This section describes the operation of the CMI-14.

Operation
(Refer to drawing CMI-14)

Scanning and Buffering
The five slave key scan address lines from the master keyboard controller are fed straight through to the CMI-11 switch modules. The output from each module is buffered by a 741SC in a non-inverting configuration and fed to the master controller. A 4-pole dual-in-line (DIL) switch allows the input of each buffer to be pulled to nearly -5V for testing purposes. In the event of a switch module being unplugged, closing the switch corresponding to that module simulates all keys released. Two or more floating buffer inputs result in the keyboard controller going into overflow due to sensing too many keys pressed. All switches should normally be open, otherwise the velocity sensing system will not work.

Power Supplies
The CMI-14 is supplied with +20V and -20V from the CMI via the master keyboard. A 4V7 zener is used on each supply side to provide +12V and -12V to the 741 buffers, and 7805 and 7905 regulators send +5V and -5V respectively to the switch multiplexers.

External Connections

SO1 - 30-Way flat cable connector

Pins 1-5	Slave switch module 1 scan address
6	N/C
7	-5V to Slave switch module 1
8	"+XV" 5V to module 1
9	Ground to module 1
10	MD1 module 1 multiplexed output
11-20	Slave switch module 2 connections as for 1
21-30	Slave switch module 3 connections as for 1

SO2 - 25-Way D series external connector

Pins 1-2	Ground
3-7	Slave keyboard scan addresses
8	Ground
9-11	Slave multiplexer outputs
12-21	N/C
22-23	-20V supply
24-25	+20V supply

The analogue controls permit the musician to convey information to the CMI about tonal quality in a continuously variable manner (actually a large number of digitized values). This controller board consists of two switches, three rotary pots, two rotary wheels and two lamps. This section describes the operation of the CMI-319.

Operation
(Refer to drawing CMI-319)

Rotary Pots
There are three rotary pots on this controller board, and they are labelled control 1, 2 and 3. The pots are connected between the +5V and -5V supplies. By turning the pot, the potential of the wiper is made to vary between +5V and -5V. No adjustment is possible or necessary.

Switches
There are two switches, labelled switch 1 and 2. When a switch is depressed, it connects its line (SW1 or SW2) to +5V. The line is pulled to ground when the switch is open.

Lamps
There is a lamp inside both of the switches. The lamp is independent of the switch position. Each lamp is connected between +20V and the lamps signals, LAMP1 or LAMP2. These signals are controlled by a MC75452 at J2, which is in turn controlled by LP1 and LP2. Refer to circuit diagrams CMI-10-03 and CMI-10-04.

Wheel controls

Wheel 1 is a pitchbend controller. It is used to determine pitchbend frames for MIDI. This control allows the musician to alter the pitch of a note or chord by up to +/- 128 semitones. It is fitted with a spring return, which always returns the control to the central position when not being held. The central position corresponds to no pitch alteration.

Wheel 2 is a modulation wheel. It is not fitted with a spring return, so will remain in the same position when released. Apart from this difference, it is mechanically and electrically the same as the pitchbend control, however the software demands much smaller tolerances on the pitchbend.

Each wheel is connected to the shaft of a rotary pot. This pot is connected between +12V and -12V. Due to mechanical restrictions, the wiper is only able to traverse a smaller range of voltages. An LF353 dual op-amp is used to adjust the output voltage to the range +5V to -5V with 0V at the central position. This is achieved by using two 500K 10-turn trim-pots for each op-amp. The first trim-pot is connected between +5V and -5V, and the wiper is connected to the + input of the op-amp to provide offset adustment. When this voltage is the same as that of the - input, the op-amp output is 0V. The other trim-pot is used as a variable resistor between the output of the op-amp and the - input to provide gain adjustment. This allows control of the range of the output voltage. Two back-to-back diodes are connected, to the output of the op-amp to provide a 0.6V dead-zone around the central position. Finally, two 1N914 diodes are connected between the output signals MOD and PITCH and +5V to prevent circuit damage if the trim-pots are incorrectly adjusted.

Adjusting the wheels

Incorrect adjustment of the pitchbend controller will result in the following problems:

a) The CMI will be out of tune. This is due to the pitchbend assuming a non-zero voltage when not being held.

b) The pitchbend will be unable to bend the sound up or down by one whole octave. This is due to insufficient range on the pitchbend.

c) Turning the pitchbend appear to the CMI as being accompanied by the turning of the other controls. This is due to the range of the pitchbend output voltage, PITCH, exceeding the +5V and -5V supplies, causing the 4051 multiplexer at I3 to become overloaded.

Similar problems will occur with wheel 2, except that this wheel is often unused.

To adjust the wheels, follow these steps:

1) Remove the case of the keyboard. Refer to page 8.4.

2) Unscrew the control panel. Refer to page 8.6.

3) Activate diagnostics, and proceed to the main event loop. Refer to 8.18

4) Set the range of each control to a small value. The pitchbend range trim-pot is the second from the top, wheel 2 at the top. Turn it anti-clockwise to reduce the range.

5) Set the central value to $80. The pitchbend centre adjust trim-pot is the 4th from the top, wheel 2 3rd from the top. Turn it clockwise to reduce the values.

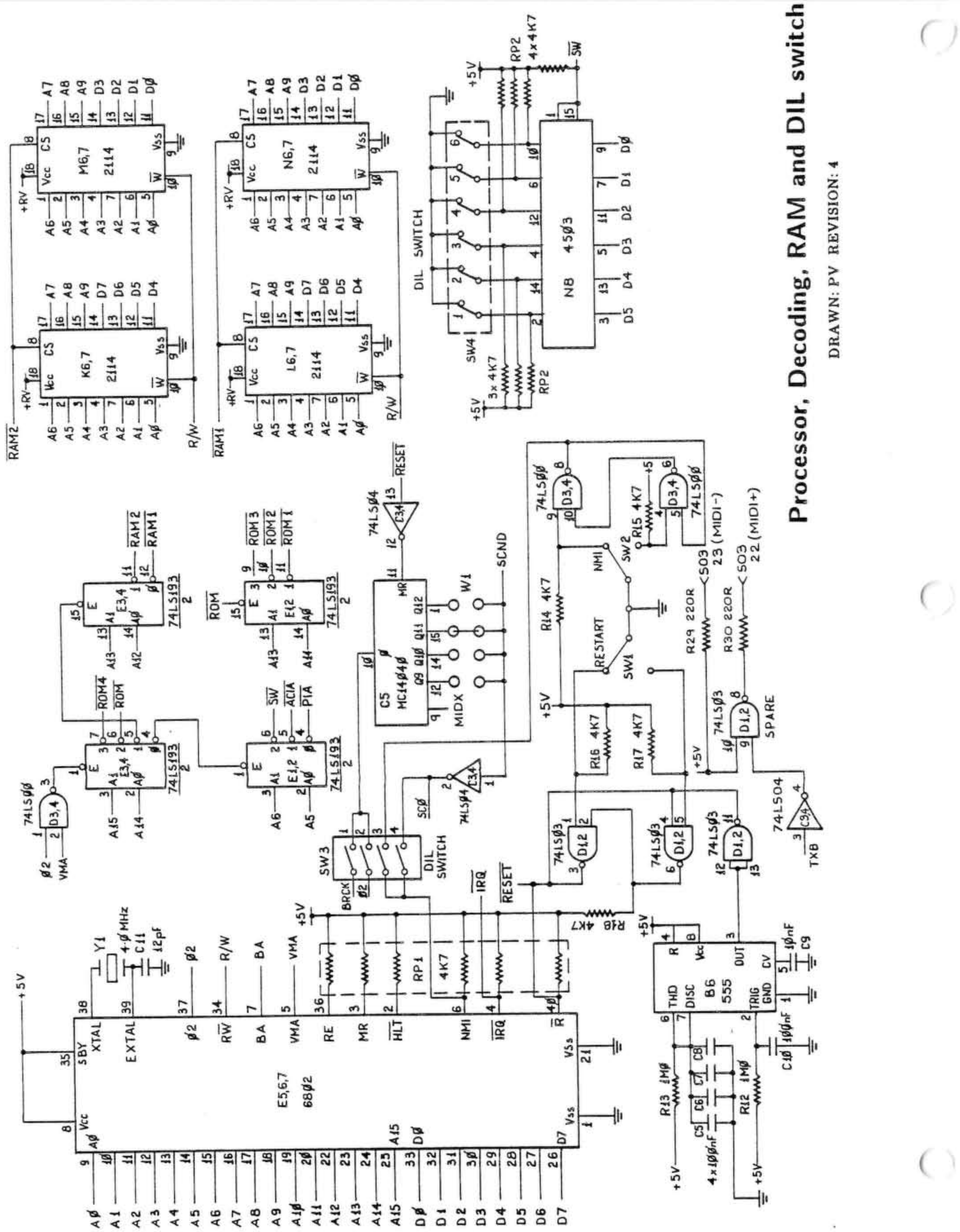
6) Turn the range-adjust trim-pot clockwise to increase the range. Adjust the centre-adjust trim-pot to make the range symmetrical about $80. Repeat step (6) until the wheel just reaches the endpoints of $0 and $FF. Overshoot will result in phantom turning of other controls due to the 4051 at I3 becoming overloaded. Finally, make sure that the centre is still $80.

7) Alternatively, you may use a digital voltage meter. Pin 2 of the 4051 at I3 is the output of the pitchbend. Pin 4 is the output of wheel 2. They should go from -5.00V to +5.00V with the voltage when the wheel is in the central position being 0.00V. In practice, all three parameters can rarely be satisfied, however you should try to achieve maximum possible accuracy.

External Connections

SO1 - 20-Way flat cable connector

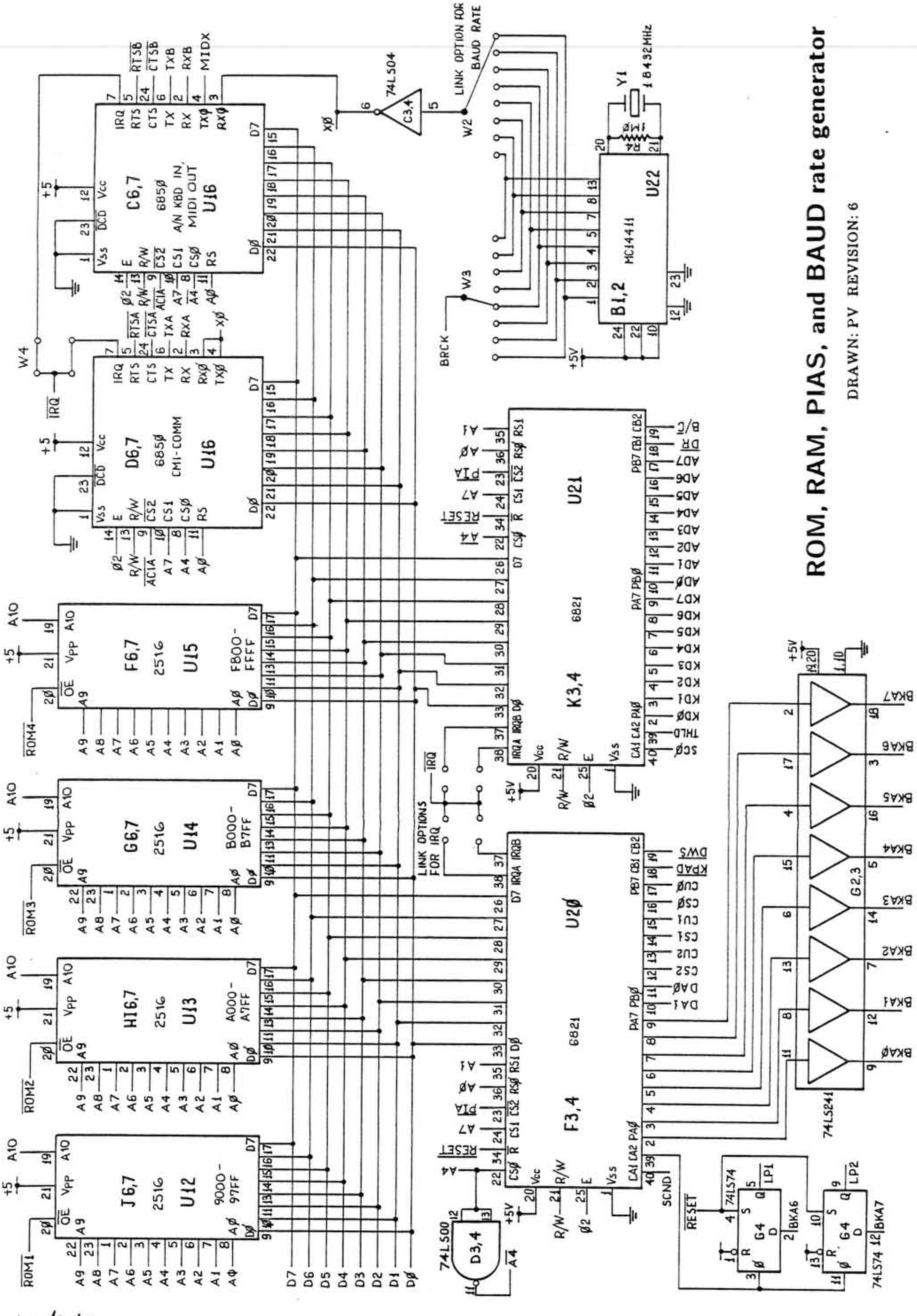
Pin 1	Ground
3	+12V
4	Output of wheel 2
6	Output of pitchbend
7	-12V
9	-5V
11	Pulled low to light lamp 2
12	Pulled low to light lamp 1
13	State of switch 2
14	State of switch 1
15	Output of pot 3
16	+20V unregulated
17	-5V
18	+5V
19	Output of pot 2
20	Output of pot 1

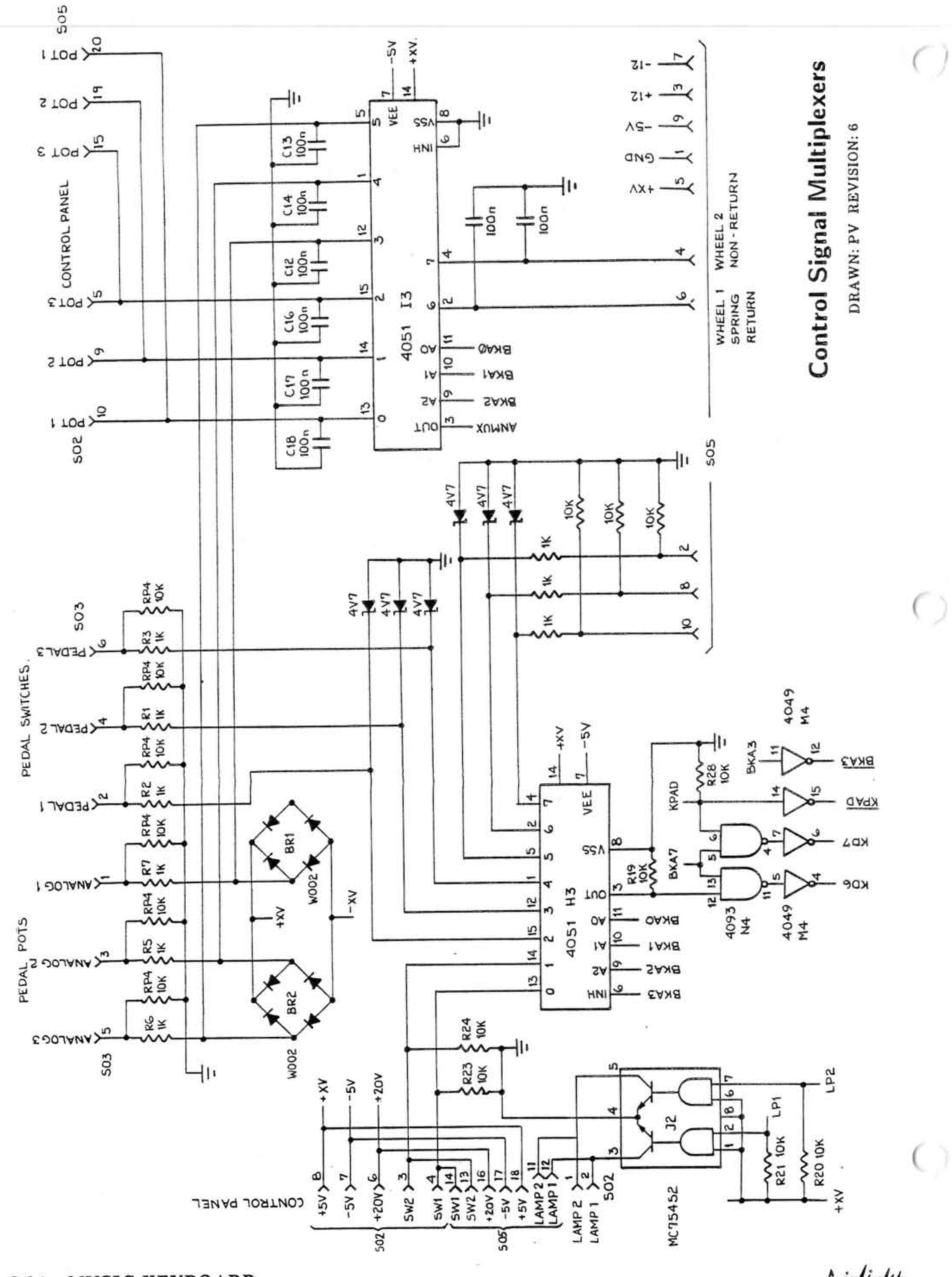

Processor, Decoding, RAM and DIL switch
DRAWN: PV REVISION: 4
E5,6,7
6802
K6,7
2114
M6,7
2114
L6,7
2114
N6,7
2114
N8
4503
C5
MC14040
B6
555
DIL SWITCH
SW3
SW4
RP1
RP2

 fairlight

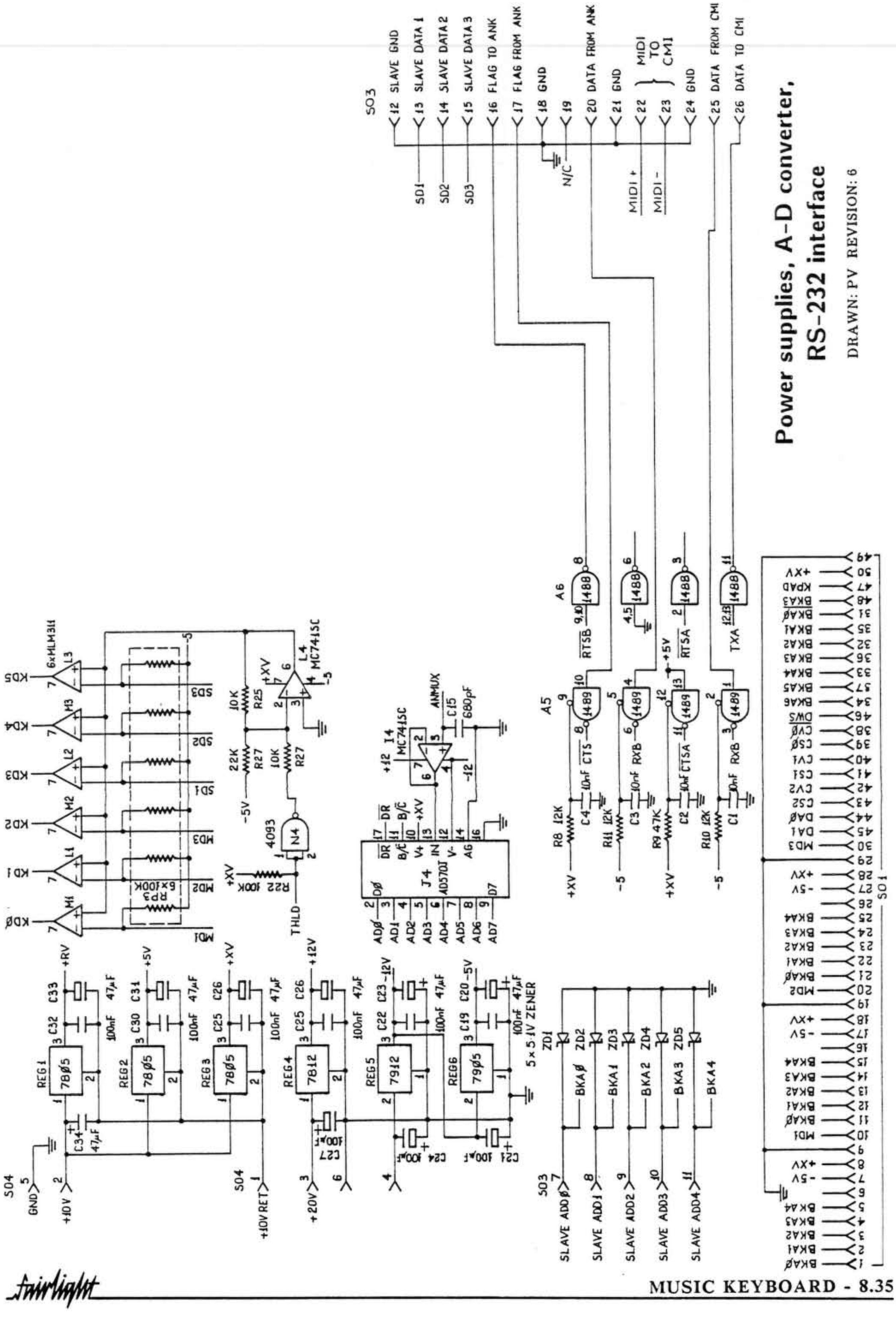
ROM, RAM, PIAS, and BAUD rate generator

DRAWN: PV REVISION: 6



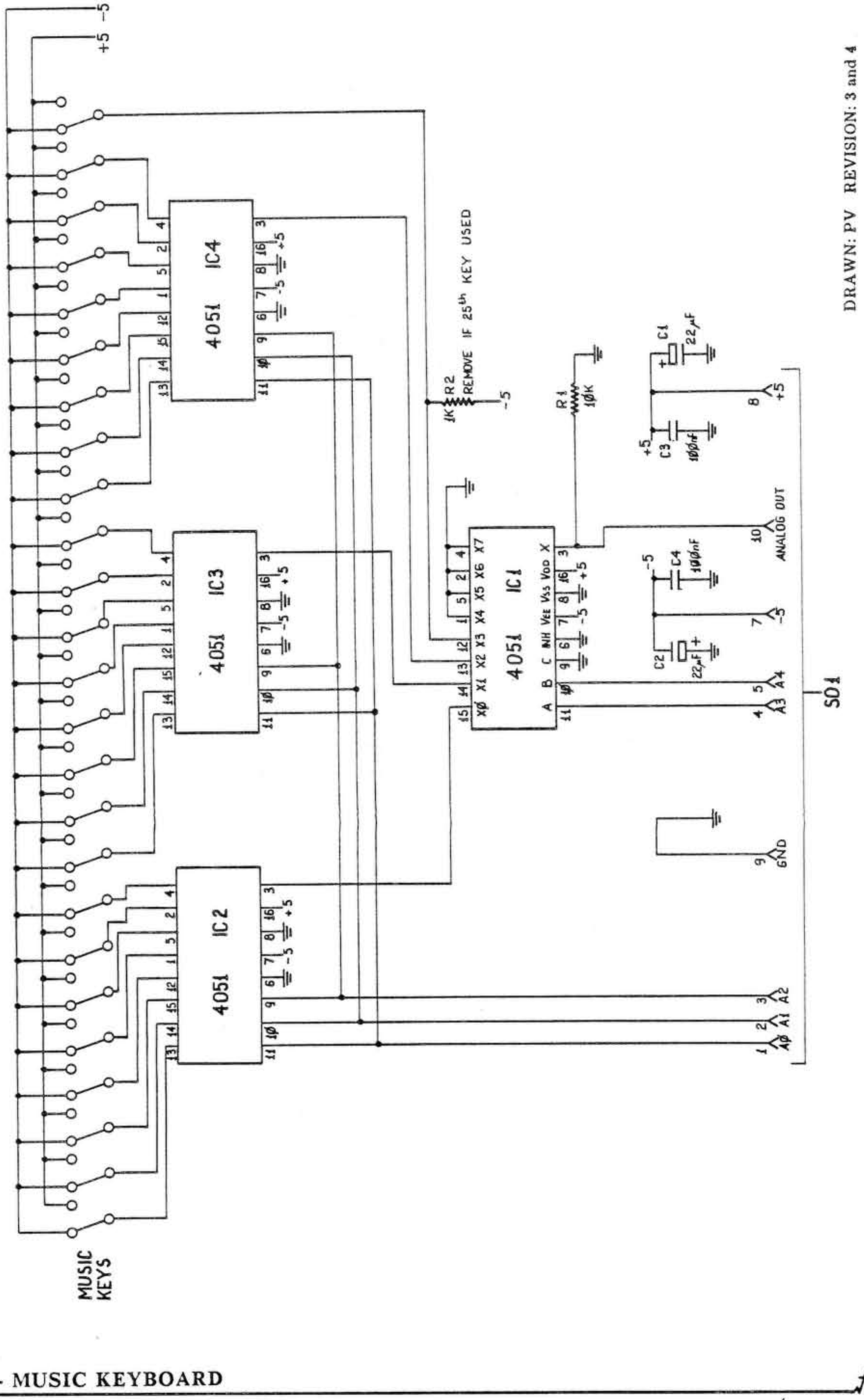

Control Signal Multiplexers
DRAWN: PV REVISION: 6
4051 I3
4051 H3
4093 N4
4049 M4
MC75452
CONTROL PANEL
PEDAL SWITCHES
PEDAL POTS
WHEEL 1 SPRING RETURN
WHEEL 2 NON-RETURN
BR1
BR2
J2

fairlight

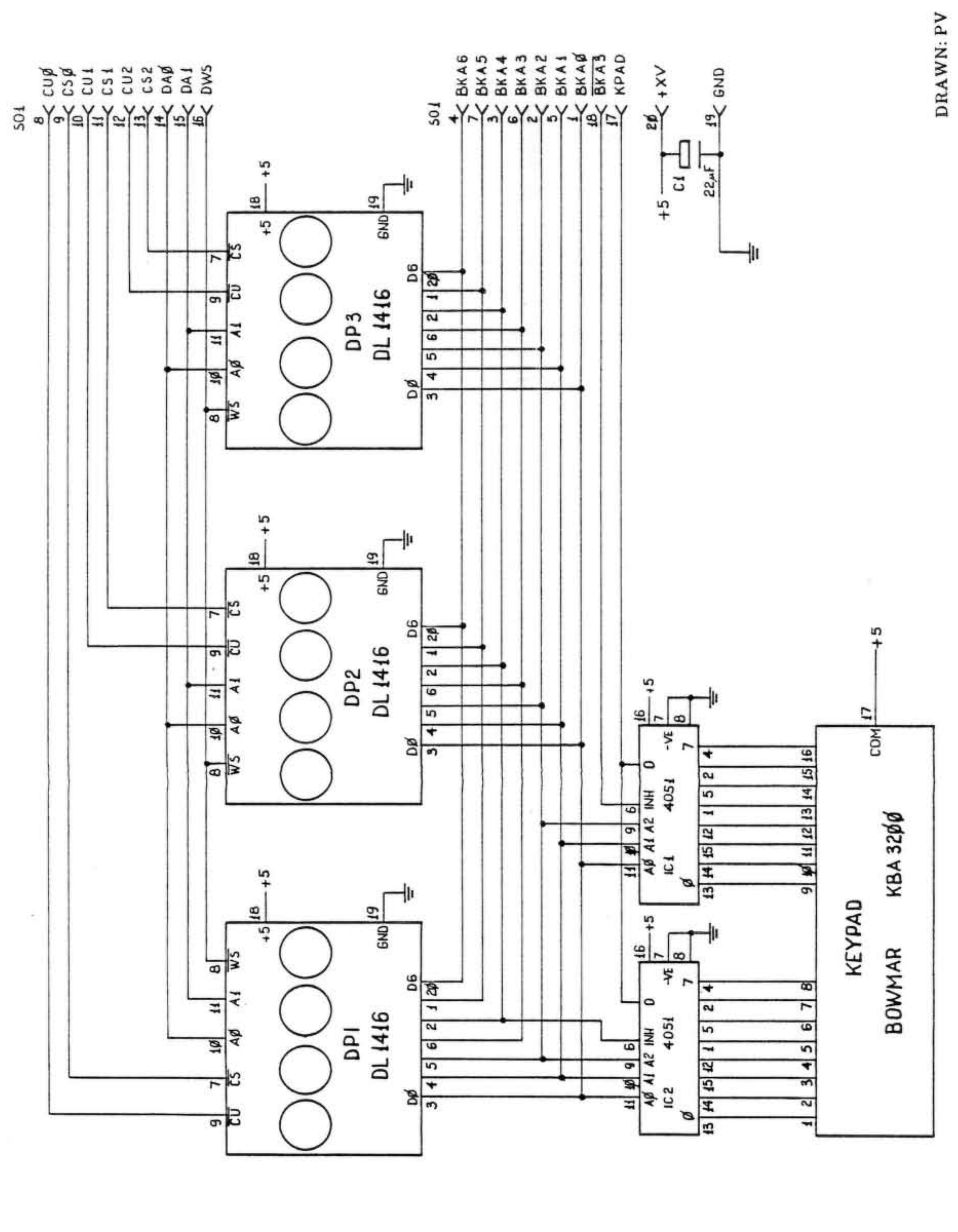


Power supplies, A–D converter, RS-232 interface

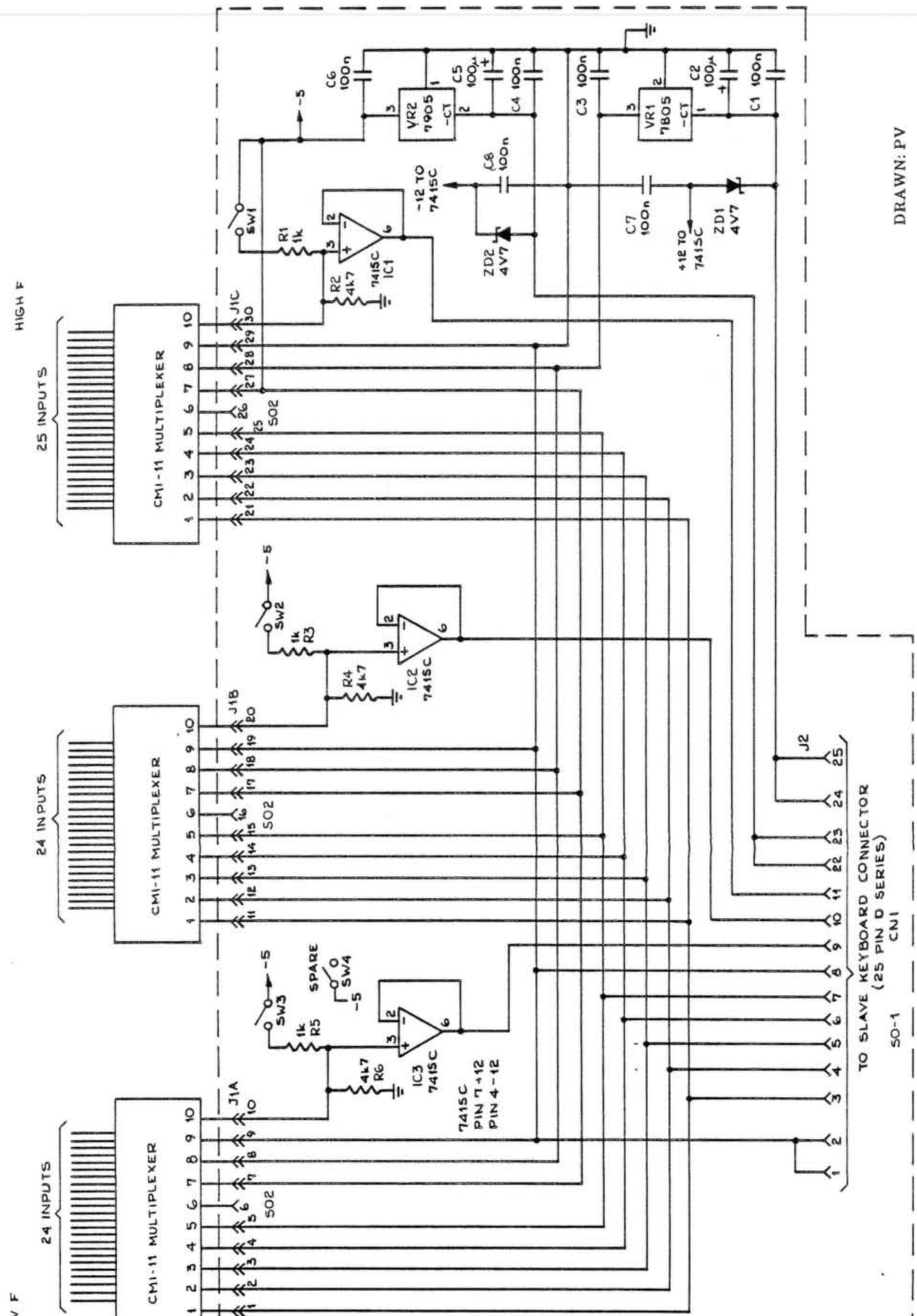
DRAWN: PV REVISION: 6


DRAWN: PV REVISION: 3 and 4
MUSIC KEYS
+5 -5
4051 IC4
4051 IC3
4051 IC2
4051 IC1
REMOVE IF 25th KEY USED
R2 1K
R1 10K
C1 22μF
C2 22μF
C3 100nF
C4 100nF
ANALOG OUT
GND
A0 A1 A2 A3 A4
SO1

fairlight


DRAWN: PV
SO1
CUØ
CSØ
CU1
CS1
CU2
CS2
DAØ
DA1
DWS
BKA6
BKA5
BKA4
BKA3
BKA2
BKA1
BKAØ
BKA3
KPAD
+XV
GND
C1
22µF
+5
DP3
DL 1416
DP2
DL 1416
DP1
DL 1416
4051
IC1
IC2
KEYPAD
BOWMAR
KBA 32ØØ
COM

CMI-14-01 SLAVE INTERFACE



fairlight