***** NOTE *****

The card edge connector is numbered so that all of the odd number pins are on one side of the board while all of the even numbered pins are on the other side. The card has the number "2" on the component side of the board and the number "1" on the other side of the board. Pin 1 is opposite pin 2. On the component side of the board the pin numbers increase from right to left while on the other side of the board they increase from left to right.

MBP

Acknowledgement

The MBP Clock and Analog to Digital Printed Circuit Board Kit ia an extension and refinement of a system design created by Mr. Gary Emmich of the Northern New Jersey 99er User's Group which was distributed to the Public Domain by Mr. Tony Albanese of the same group. MBP is indebted to them for providing us with the impetus to create this kit which we have been considering for a long time.

Compatibility with TIBBS(tm), an electronic bulletin board created and sold by Mr. Ralph Fowler (1881 Schillings Rd Kennesaw, GA 30144) has been assured by initial efforts on our part to implement this kit on Wichita TIBBS and further collaboration with Mr. Fowler. We are indebted to Mr. Fowler for the creation of TIBBS and the collaboration which insures that this kit will remain compatible with future TIBBS updates.

We have made every effort to be certain this kit is easy for you to complete. If you are having problems with any part of this kit please check Wichita TIBBS (316-681-3167) to see if there are any messages concerning your problem. String Scan for "MBP" to locate messages faster. Also check th"(L)atest Clock Info" file. Someone else might have already brought it to our atteneion. If so we will leave a message on the BBS as to the correction necessary. If you find no such message, then you are the first to find the problem. Leave us a message and we will advise you promptly of the corrections necessary and leave a message for others. We are anxious for you to be pleased with your clock so please let us know if you are having any problems.

Introduction This documentation contains all of the information needed to construct and use the MBP Clock/ADC pcb Kit. It contains kit assembly instructions, system checkout procedures, and general usage instructions. You should be able to assemble this kit and have it functioning in your PEB in approximately 2 hours.

The system contains a battery backed real time clock and an 8 input channel multiplexed, 8bit, analog to digital converter. Once initialized, the clock will keep time with the PEB power turned off. You can even remove the card from the PEB and reinstall it without affecting the clock. The analog to digital converter can be used to monitor any electrical signal in the Ø to 5 volt range. The clock and ADC are memory mapped so that they can be accessed via software PEEK instructions. The kit is designed and the memory mapped so that you need not be concerned with interaction with any other software or hardware (except of course for the use of one PEB card slot). Use of this kit does not restrict the utility of your computer in any way. It does **not** require that you give up the use of one of your RS232 ports.

The MBP partnership was set up to develop and market this Clock/ADC kit and future products. We are convinced that the TI 99/4A Home Computer is a well designed and fabricated product that will provide its owners with many years of reliable service. The partnership is dedicated to making your computer as useful as possible.

The design of this product is in the Public Domain and not copyrighted. However, the **implementation** of this design is the property of MBP and is considered to be **copyrighted.** Specifically, the printed circuit board layout and this documentation package are copyrighted property of MBP and must not be copied in any form without the expressed written consent of MBP. Voilators of these copyrights can and will be prosecuted.

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ASSEMBLY INSTRUCTIONS

1. **Kit Inspection** Review the list of materials shown in Appendix A to insure that you recieved a complete kit. Inspect the printed circuit board for damage. We have inspected the pcb prior to shipment. Please inspect it again before beginning assembly. If the board is cracked or any lands are loose, please leave us a private message on Wichita TIBBS 316-681-3167 (modem) or write us a letter at the address shown on the front of this package. Do **not** solder on the pcb if it is damaged! We will have difficulty dealing with pcb defects after you begin the assembly process.

2. **Parts and Tools Review** Review the parts and tool list of Appendix A to insure that you have everytning needed to complete the project. You may, of course, start assembly before you have all of the parts but we recommend that you at least make arrangements to recieve all of the parts before you start since you should be able to assemble this kit in one evening and your frustration level will be very high if you have to stop construction to wait for parts.

3. **To Box or Not to Box.** We have operated our implementation of this kit without an enclosure on the card and have observed no evidence of electromagnetic interference of any kind. It has been operated in PEBs with both the CorComp disk controller card and the Foundation 128K card for extended periods of time. One is in daily operation on Wichita TIBBS and we have observed no ill effects. If you decide to enclose your card, now is the best time to make provisions for this. The card has been layed out so that TI or Corcomp card enclosures can be applied without difficulty. However, because we have been able to operate the card without an enclosure, we have designed it so that the card edges fit in the alignment slots of the PEB. If you intend to mount the card in an enclosure, it will be necessary to trim the card edge along the dotted line as shown on the Parts Layout. The card can be trimmed later but it must be done with the utmost of care after the components are installed. While trimming the card we recommend that you apply a pressure sensitive coating such as foam tape to prevent damage to the printed circuit area during the trimming operation.

4. **Discrete Component Installation.** The discrete components should be installed with reference to the Parts Layout. Reference directions are defined with the component side of the board up and the PEB connector at the bottom.

R1 1Kohm resistor (brown,black,red) ___
R2 1Kohm resistor (brown,black,red) ___
R3 1Megohm resistor (brown,black,green) ___
R4 220 ohm resistor (red,red,brown) ___
R5 1Kohm resistor (brown,black,red) ___
R6 200Kohm resistor (red,black,yellow) ___
13 each .1mf capacitors (shown as "c") ___
C4 20pf disc capacitor ___
VC 3.5 to 20 pf trimmer capacitor ___
C1 22mf electrolytic capacitor, + lead right ___
C2 22mf electrolytic capacitor, + lead right ___
C3 22mf electrolytic capacitor, + lead downt ___
D1 1N914 diode, cathode(banded end) to right ___
D2 1N914 diode, cathode(banded end) to right ___
D3 1N914 diode, cathode(banded end) down ___

NOTE: Please check to see that the polarity of the electrolytic capacitors and the diodes are correct!

5. **5 Volt Regulator Installation.** Bend the 3 legs on the 7805 regulators as shown on the Parts Layout. The legs are bent so when the regulator is installed, the metal tab will be against the pcb and the hole through the tab and the hole in the pcb will be in line.

RG1 with metal side right and legs left ___
RG2 with metal side down and legs up ___

Apply +12VDC to pin 1 of the edge connector using the large metal area at the top of the pcb as a ground. Measure the outputs of the regulators.

RG1 4.9VDC ____ 5.3VDC (IC6/P23)
RG2 5.1VDC ____ 5.6VDC (IC6/P24)

8. **LED and Clock Crystal.** Install the LED with the cathode (short) leg in the bottom hole and the bottom edge of the LED standing up 3/8 inch above the PCB. Now bend the LED over toward the left as shown on the Parts Layout.

***** CAUTION *****

Do **NOT** use an ohmmeter to check anything on the board after this point. This could damage the ICs!!

7. **Integrated Circuit Installation.** We recommend sockets only on IC6 and IC7. These are the expensive chips and you'll want to take care installing them. The cost of sockets is almost equal to the cost of the other chips. Thus if you populate the rest of the locations with sockets you'll increase the cost of the kit. On the other hand, if you do not feel comfortable soldering on the chips directly (they can be damaged by excess heat) then you may want to socket all of the ICs. If you decide to do this, you'll want to use good quality sockets to insure long term reliable operation of the kit. Now install the integrated circuits with their #1 pins to the upper left.

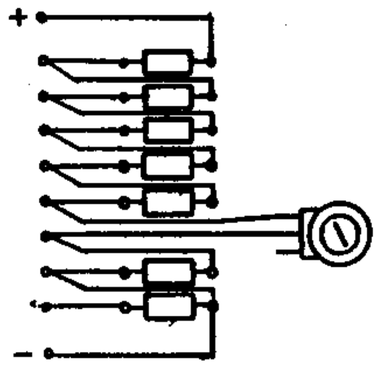
IC1 555 ___
IC2 74LS244 ___
IC3 74LS244 ___
IC4 74LS244 ___
IC5 74LS245 ___
IC8 74LS08 ___
IC9 74L138 ___
IC10 74LS138 ___
IC11 74LS93 ___
IC12 74LS368 ___
IC socket for IC6 24 pin, pin 1 locator to the left ___
IC socket for IC7 28 pin, pin 1 locator to the left ___

8. **Battery Installation.** Remove the battery from the case. Solder the battery case to the pcb with the pin located at the battery retainer clip down. Slide the battery back into the battery case being careful not to bend the battery retainer clip upward. The + side of the battery should be up. You're done!!

SYSTEM CHECKOUT

Clock. Turn off your PEB for at least 3 minutes. Remove the top and slide the card into any slot, being careful to get the card edges in the guides. Gently press on the top of the card to engage the card in the edge connector. Inspect the card to see that it is not in contact with any other cards in the box. Replace the PEB lid. Turn on the PEB. The LED on the clock card should be off. Install your XBASIC module and turn on the console and the monitor. You should now get the TI menu screen. Place the MBP disk in drive one. Now the moment of truth!! Select XBASIC. Type RUN "DSK1.CLOCK". Follow the prompts. Pretty neat, no?

ADC. Build a resistor ladder like that shown below. Measure the resistance between pins 5 and 23 of the external circuit to insure that it is greater than 5Kohms. After you have purchased a 26 pin edge socket, plug it onto the ADC Port at the rear of the card. Number 1 pin is at the top right of the card when it is plugged into the P-box. Turn on the PEB. Install your XBASIC module and turn on the console and the monitor. Place the MBP disk in drive one. Type RUN "DSK1.ADC_TEST" Change the variable resistor and watch the numbers on the screen change. Remove the 5VDC lead from the test circuit; all display values will become "0". Reinsert the 5VDC lead and remove the ground lead; all display values will become "255".



This resistor ladder can be built on a project board and connected with a cable to the socket. We used 1K ohm for the 7 resistors and a 1K variable. You can use anything you might have on hand, but be careful not to short out the + directly to the -. There you have it. The whole system works. Now the fun begins, develop your own applications and enjoy!

Analog to Digital Converter Usage. The eight multiplexed, 8 bit, analog to digital converter input channels allow you to monitor anything you can convert to a relatively slowly varying electrical signal in the 0-5 volt range. The BASIC or XBASIC interpreter functions so slowly that you needn't concern yourself with the speed of the converter. If you decide to use the converter with an assembly level language program, you'll need to add a delay loop or perform some other function such as converting the previous measurement to some other scaling to allow the converter time to complete its job.

We have brought out the system ground and +5VDC on pins of the external connector. If the sensors you're using have a combined current requirement of 0.1 amps or less, you may power them from this source. The safest approach is to power the sensors from an external power source using the edge connector ground and the +5VDC as a reference.

***** CAUTION *****

Attempts to draw more than 0.1 amp of current from the ADC port may overheat and destroy the RG1 regulator. The ADC inputs are designed to operate over the range of -0.1 to +5.1 volts. Voltage inputs outside this range may damage the ADC!!!!

****

With the exception of these two limitations, you are free to use the ADC inputs any way you like.. The functions which can be provided by the computer, clock, and ADC inputs are limited only by your imagination! Some of the ideas we've had and intend to persue in the near future are:

1) A data logging weather monitor station. We'll be able to log wind direction and velocity, air temperature, barometric pressure, relative humidity, and outside light level. If we could then add the ability to monitor our home energy consumption, we'd be able to draw some correlations about the severity of the winter or summer and its effect on home energy consumption.
2) Security systems also provide some interesting possibilities. Motion sensors and smoke detectors usually provide outputs which can be monitored with the addition of minimum circuitry. Simple reed switch closures can be used to determiine when various doors and windows are opened and closed. The addition of the clock and your printer or disk will allow you to keep track of the time of various events.Based on the time of the occurance your computer can be programmed to ignore the event(other than logging it) or sound an alarm via the sound generators built into your computer.
3) A simple sound switch can be employed to log the times when your telephone rang but you were not at home. It could also be used to alert you to tell the kids to turn off the TV when they're supposed to be doing homework or sleeping and you're busy working(?) with your computer.
4) You can also monitor for high water in the basement or high temperature in the freezer.
5) How about a water temperature measurement in the

swimming pool and an outside air temperature measurement to tell you when to cover the pool or turn on the water heater?

I'm sure you'll be able to think of many more potential applications. If you implement one and find it to be useful, please leave us a message on Wichita TIBBS. Other folks might also like to implement your ideas. We're planning to send out infrequent newsletters to kit purchasers and would be pleased to serve as a clearinghouse for applications.

Clock Usage The real time clock in your kit contains a calendar which when combined with the power of your computer provides some interesting potential applications. You could program an appointment calendar that determines the day, the week, or the month and searches a file to display appointments for you. Birthdays, anniversaries (think how much your wife or husband would like that), time to write various checks,recording of events, etc. could be reviewed by simply running the program since your computer now knows the day of the week, the date, and the month. It would also be nice to add dates to various favorite programs you have written to document the output schedule. Financial analysis programs, disk lists, etc. could all benefit from an antomatic feature of this type.We haven't figured out how to modify TI-WRITER or MULTIPLAN to be able to use this function but wouldn't that be nice! It would also be helpful to be able to automatically date files which we download from various telecommunications sources.

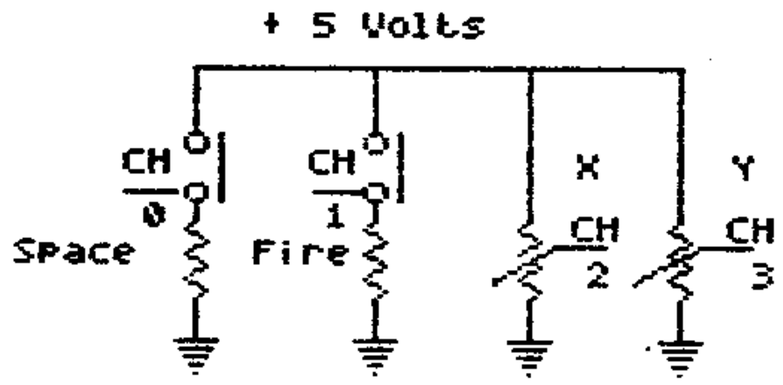
Appendix A

A. Kit Contents
   1. SSSD Disk filenames CLOCK, ADC_TEST
   2. Printed Circuit Board
   3. Munual

B. Parts List
   1. Integrated Circuits
      a. 3 ea 74LS244 — IC 2,3,4
      b. 1 ea 74LS245 — IC 5
      c. 2 ea 74LS138 — IC 9,10
      d. 1 ea 74LS93 — IC 11
      e. 1 ea 74LS368 — IC 12
      f. 1 ea 74LS08 — IC 8
      g. 1 ea MM58167 — IC 6
      h. 1 ea ADC0809 — IC 7
      i. 1 ea 555 — IC 1
      j. 2 ea 7805 — REG 1+2
   2. Capacitors
      a. 13 ea .1mf disk 35 volt min. — C
      b. 3 ea 22mf electrolytic 15 volt min. — C1,2,3
      c. 1 ea 20pf disk 35 volt min. — C4
      d. 1 ea 3.5 to 20pf variable capacitor — TRIMMER CAP.
   3. Resistors
      a. 1 ea 1 Megohm 1/4 watt
      b. 1 ea 200 Kohm 1/4 watt
      c. 3 ea 1 Kohm 1/4 watt
      d. 1 ea 220 ohm 1/4 watt
   4. Miscellaneous
      a. 1 ea 28 pin IC socket
      b. 1 ea 24 pin IC socket
      c. 3 ea 1N914 diodes
      d. 1 ea 32.768 KHz Miniature Crystal
      e. 1 ea LED
      f. 1 ea lithium battery BR 2325 1HB
      g. 1 ea battery case HB 906-ND

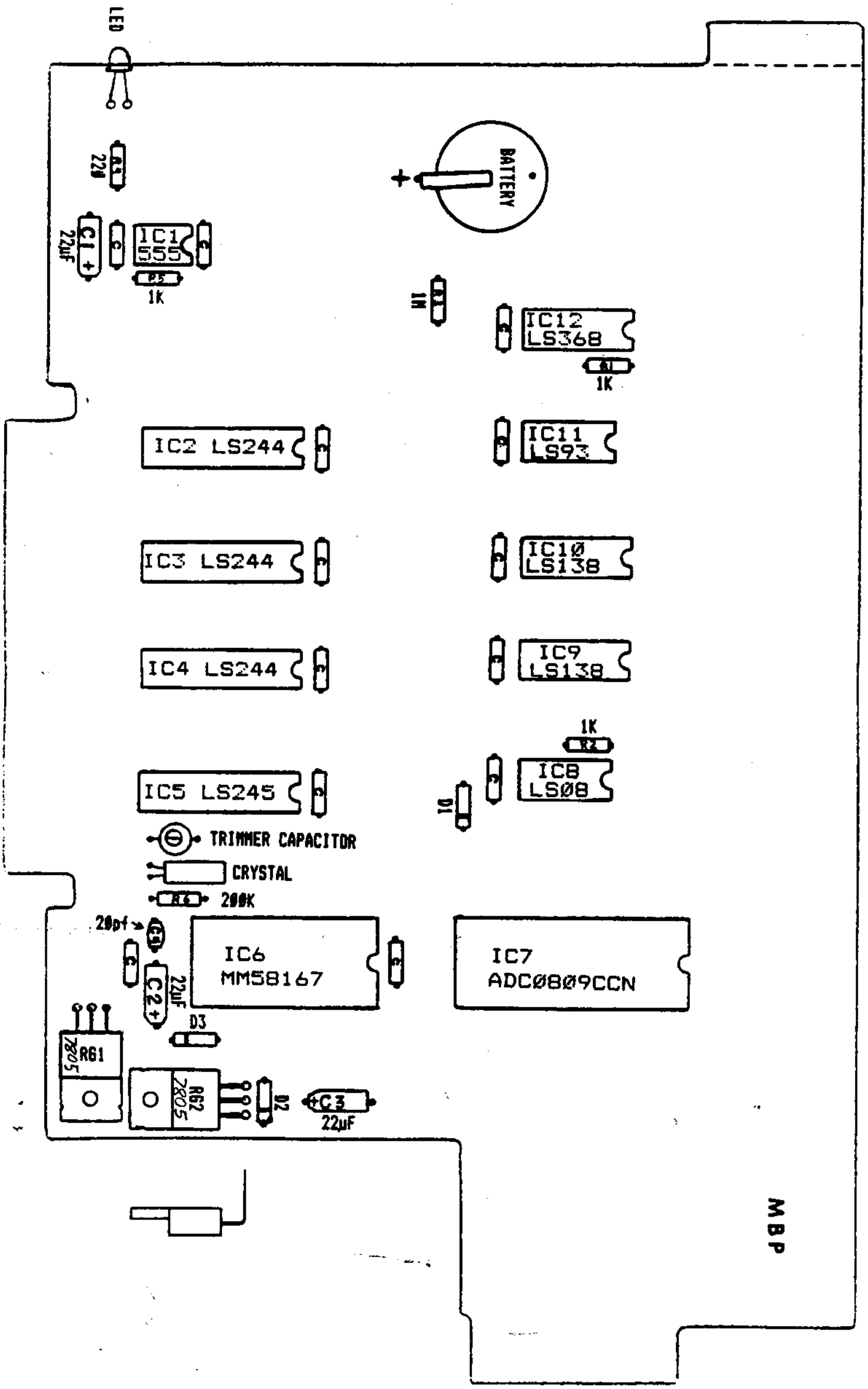
C. Tool List
   1. 1 ea 25 watt electronics soldering iron
   2. 1 ea roll of electronics solder
   3. 1 ea set of long nose pliers
   4. 1 ea volt/ohmmeter
   5. 1 ea 12 VDC power supply

MBP Analog-Joy Stick



All resistances greater
than 10,000 ohms.

TI-ARTIST Ver. 2.0


LED
BATTERY
22Ω
C1
22µF
IC1
555
1K
1K
IC12
LS368
1K
IC2 LS244
IC11
LS93
IC3 LS244
IC10
LS138
IC4 LS244
IC9
LS138
1K
IC8
LS08
IC5 LS245
TRIMMER CAPACITOR
CRYSTAL
200K
20pf
C2
22µF
IC6
MM58167
IC7
ADC0809CCN
D3
7805
RG1
7805
RG2
D2
+C3
22µF
MBP

11

RBDENA

IC12 3 13 14 15 1K +5

IC 3 (244) A0 A1 A2 A3 A4 A5 A6 A7 — 43 44 41 42 39 40 37 38 — A0B A1B A2B A3B A4B A5B A6B A7B — 18 16 14 12 9 7 5 3

IC 10 (138) 1 2 3 4 5 6 11

IC 9 (138) 1 2 3 4 5 6 14 13

IC 4 (244) A8 A9 A10 A11 A12 A13 A14 A15 — 35 36 33 34 31 32 29 30 — A8B A9B — 18 16

IC8 1 2 3

LED 220

IC1 2 3 1 5 8 7 6 4 +5 1K 22µf

IC 6 (SBIC7) 1 2 3 9 8 7 6 5 — 10 11 15 16 17 18 19 20 21 22

200K 3-30 pf 20 pf

VR1 (7805) VR2 (7805) .1 .1 +5 22µf 22µf D3 D1 D2 1 MEG 5V CLK

IC 7 (ADC 0809) 23 24 25 10 1 6 22 — 26 27 28 1 2 3 4 5 — IN0 IN1 IN2 IN3 IN4 IN5 IN6 IN7 — 21 20 19 18 8 15 14 17

IC 11 (93) 1 2 3 8

IC 2 (244) PH3 WE DBIN MEMRM — 50 54 52 56 — PH3 WE DBIN MEMRM — 2 4 6 8 — 18 16 14 12

DBINB MEMRMB IC8 5 4 6 1K +5

IC12 2 3

IC8 13 12 11

IC8 10 9 8

IC12 10 9

IC 5 (245) D0 D1 D2 D3 D4 D5 D6 D7 — 28 25 26 23 24 21 22 19 — 18 17 16 15 14 13 12 11 — 2 3 4 5 6 7 8 1