BYTE MPU BOARD

FUNCTIONAL DESCRIPTION

The BYTE MPU Board controls and processes all instructional data within the

BYT-8 Computer (or any S-100 bus compatible computer). It features an 8080A

microprocessor, a crystal controlled clock generator, and an optional vector

interrupt, and contains eight input (DI$\emptyset$-7) and eight output (DO$\emptyset$-7) lines

to and from the motherboard (S-100 bus), and logic control circuits. A

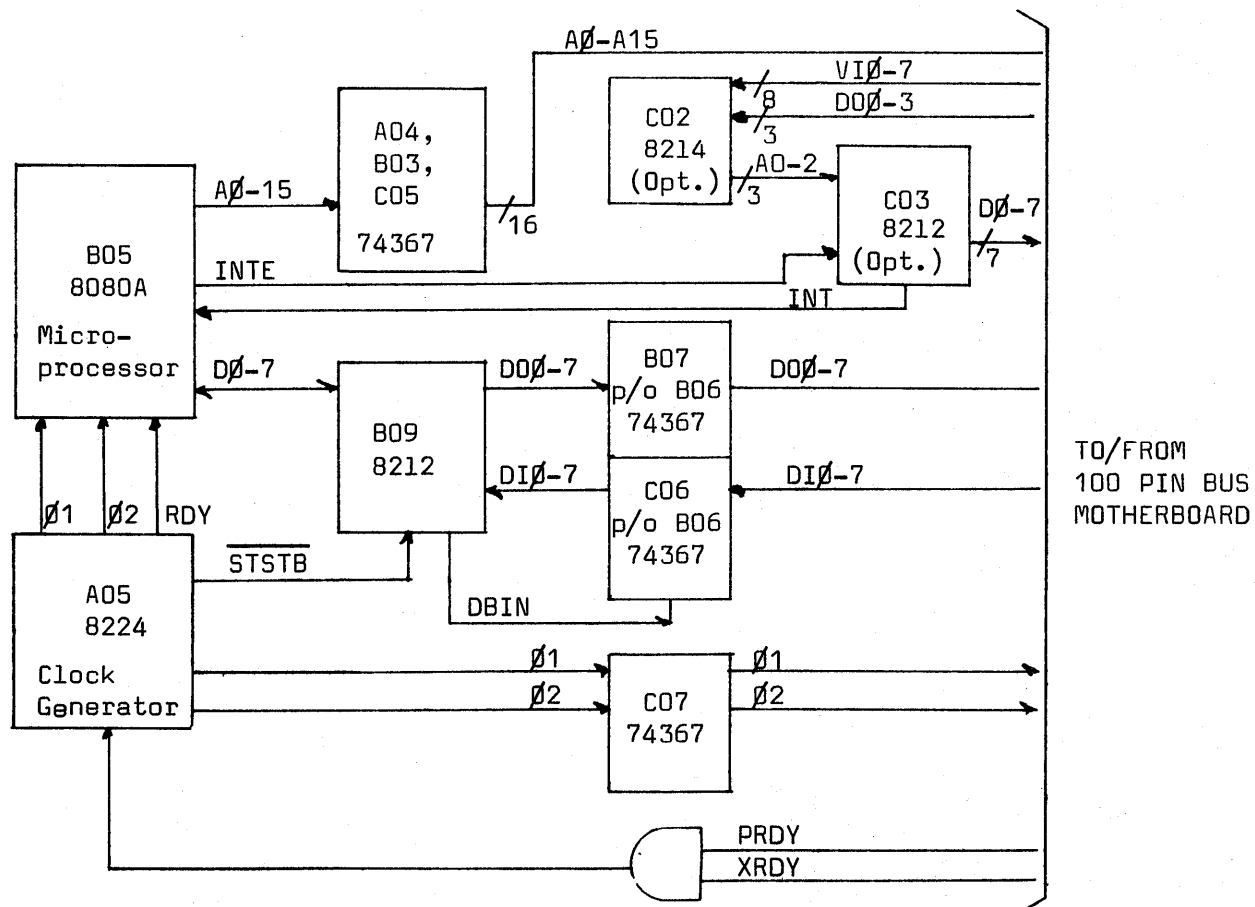functional block diagram is shown in Figure 1.

FIGURE 1. Functional Block Diagram for the MPU Board

THEORY OF OPERATION

The primary feature of the MPU Board is the 8080A microprocessor IC; most of the Board provides support for this unit. The MPU Board interfaces between the 8080A and the data and address buses, clock and timing signals, and the necessary voltage regulation for the 8080A and the other ICs. (The internal operation of the 8080A is covered in the user's manuals available from the various manufacturers.)

The 16 address lines from the 8080A drive the address bus (AØ-15) through A04, B03, and C05 (three 74367 or equivalent IC's). The 74367's are tri-state buffer drivers. They are disabled through the $\overline{\text{ADD DSBL}}$ line on pin 22.

Three more 74367's, B06, B07, and C06, are connected as the DATA IN (DIØ-7) and DATA OUT (DOØ-7) bus drivers. The DATA OUT buffers are controlled by the $\overline{\text{DO DSBL}}$ signal on pin 23. The data bus is also connected to J1, the data bus socket, and to the status byte latch, B09 (8212). The data bus socket can be used to connect the front panel to the data bus. The latch, B09, transfers the Status Byte to the 100-pin motherboard through C07 and C09 (two 74367's). These two 74367's are disabled by the $\overline{\text{STAT DSBL}}$ signal at pin 18. The 8212 (B09) is latched by the $\overline{\text{STSTRB}}$ signal from A05 pin 7 to store the status data for each instruction cycle.

A resistor array (A08) consisting of eight 4.7k ohm resistors is connected to the bi-directional data bus lines to ensure that during the time when the bus is not being driven, the 8080A reads all 1's. The clock generator IC, A05 (8224), and external crystal (Y1) form a two-phase non-overlapping 2 MHz system clock circuit for the 8080A. The two-phase clock is also provided through the 100-pin connector to the motherboard by way of C07 (74367). The $\overline{\text{CLOCK}}$ line (pin 49) of the motherboard is driven from the Ø2 TTL output (A05 pin 6) through a series of six inverters to provide a delay so that the phase relationship of the $\overline{\text{CLOCK}}$ signal to the Ø1 and Ø2 clocks on the

motherboard is almost identical to that produced by the MITS Altair 8800

system. The A05 (8224) also provides the power-on reset function through

the use of a 4.7k ohm resistor (A08) and a 33 uF capacitor (C30) connected

to the $\overline{\text{RESIN}}$ input of A05 pin 2. The RS (Reset) output of A05 pin 1 is

applied to the motherboard as the $\overline{\text{POC}}$ (pin 99), Power-On Clear signal.

The PRDT (pin 72) and XRDY (pin 3) signals are ANDed before being applied

to the RDYIN input of A05 pin 3 to be synchronized with the $\emptyset$2 clock before

being applied to B05 (8080A). The $\overline{\text{PINT}}$ signal (pin 73) is connected through

an inverter to B03 pin 14 (74367) and goes out pin 13 of B03 to pin 14 (INT)

of B05 (8080A). The $\overline{\text{PHOLD}}$ signal (pin 74) is synchronized with the $\emptyset$2 clock

in the D flip-flop (A03) before being applied to pin 12 of B03 and goes out

pin 11 of B05 pin 13 (HOLD).

The six processor status signals (PSYNC, $\overline{\text{PWR}}$, PDBIN, PINTE, PHLDA, and PWAIT)

are applied to the motherboard through C04 (74367). This buffer is disabled

by the $\overline{\text{CCDSBL}}$ signal (pin 19).

The +5 vdc is regulated by Q2 and Q3 (two 7805's) from the +8 vdc unregulated

supply at pins 1 and 51. The -5 vdc is regulated by Q4 (79L05) from the -16

vdc unregulated supply at pin 52. The +12 vdc is regulated by Q1 (74L12)

from the +16 vdc unregulated supply at pin 2. All three regulated supplies

are filtered by 33 uF capacitors and by 0.1 uF disc capacitors.

Vectored Interrupt Circuit (Optional)

The Vectored Interrupt Circuit consists of C02 (8214), a priority interrupt

controller, C03 (8212), an eight-bit input/output port, and associated pull-

up resistors.

The 8214 (C02) is basically an eight-level priority control unit that accepts

eight different interrupt requests, determines which has the highest priority,

compares the new interrupt level to a software controlled current status

register, and issues an interrupt to the system based on this comparison with

vector information to locate the service routine. The highest priority interrupt is VI7 and the lowest is VIØ. When an interrupt request (INTE) is presented to CO2 pin 7 (8214), it issues an interrupt to BO5 (8080A) pin 14, if the Vectored Interrupt Circuit is enabled (INTE signal from BO5 pin 16). The interrupt request is encoded into three bits (modulo 8) $\overline{AØ}$, $\overline{A1}$, and $\overline{A2}$, are applied to CO3 (8212). After the interrupt has been acknowledged by BO5 (8080A), the encoded RST (Restart) instruction is gated onto the bi-directional data bus by CO3 (8212). The processor executes the instructions and points the program counter to the desired service routine.

The $\overline{INT}$ signal (CO2 pin 5) is applied to CO3 pin 11 (STB) so that proper timing is maintained. The 8212 (CO3) is enabled when the INTA and DBIN signals from BO5 (8080A) are active, thus ensuring that the RST instruction is placed on the bi-directional data bus at the proper time.

ASSEMBLY INSTRUCTIONS

WARNING

The 8080A microprocessor integrated circuit contained in this kit is VERY SENSITIVE to static electricity. DO NOT remove it from its conductive container until instructed to do so in the Assembly section of this manual. Do not handle the container itself any more than absolutely necessary.

Before touching this IC, read the instructions in the manual very carefully, and review the MOS IC Handling Precautions below.

MOS IC Handling Precautions for AO5 (8224), BO5 (8080A), and AO9 (8212)

There are several MOS IC's in this kit that require special handling precautions. To prevent damage to the MOS IC's, read and follow the precautions listed below.

1. Keep all equipment at the same potential as the PC board, work sur-
    face, and the IC itself. This is accomplished by continuous physical
    contact with the work surface, PC board, etc.

2. Always touch the metal container first, before touching the IC itself.

3. Handle the IC by the front and rear edges, not by the pins on either
    side.

4. If the IC is to be transferred from one container into another, touch
    the metal containers together before transferring the IC.

5. Touch the PC board before inserting the IC into the board or its
    socket and maintain contact until the IC is installed.

6. Never touch anything to the IC that has not been handled by you first.

7. Wear cotton clothing, if possible, to reduce static charges, rather
    than wool or synthetic fabric.

8. Avoid placing the IC near plastic, as dry air, moving over the plas-
    tic, can develop high static charges.

Assembly Hints

Soldering - Only resin-core solder should be used. Use a fine soldering tip
and a low-wattage element, approximately 15 to 25 watts. Keep the tip clean
and well tinned. Clean the tip on a damp sponge. Apply heat to the joint
to be soldered, then apply solder to the joint, not to the tip. Remove heat
from the joint, being careful not to disturb the solder joint. DO NOT apply
heat for a long period of time. This could damage or destroy some of the
components (MOS IC's, transistors, diodes, etc.) or lift traces or pads. A
good solder joint appears smooth and shiny. Too much heat or moving the
solder joint before it cools completely creates a dull, rough finish on the

joint. This is referred to as a "cold solder" joint. It can cause many

problems that are very difficult to find. If you wish to install sockets

for all of the IC's, they are available at the nearest BYTE SHOP.

Component Placement - For a professional appearance, align all the color

coding bands in the same direction (left or down). This will make finding

a component value much easier once the board is assembled. Clip off all

excess leads protruding from the board after soldering.

Board Assembly

Compare the received parts in the kit with the parts list before starting

the assembly. Wash the board in warm water and detergent with a soft brush;

this will remove any oil, dirt, etc. that may have accumulated on the board.

Rinse the board with warm water and then rinse it with alcohol or a similar

solvent to remove the water and detergent.

Mount the cleaned pc board, component side up (pins 1 and 50 will be visi-

ble on the 100-pin connector) on top of several layers of cardboard. This

allows the component's leads to penetrate the cardboard and hold the com-

ponents in place. Follow the figures in the Assembly section for the proper

sequence of installing the components.

1. Install the capacitors, large filters, and small discs per Photo 1.

2. Install all the resistors and resistor arrays per Photo 2. The
   resistor arrays can be mounted in IC sockets, if desired.

3. Install the four voltage regulators (Q1 through Q4) and the two
   heat sinks for Q2 and Q3 with a good coating of thermal compound
   per Photo 3.

4. Install the sockets for the MOS IC's, A05, B05, and B09, per Photo
   4. If desired, install sockets for the other IC's at this time.

Stop the assembly at this point and check for shorts and solder bridges

around the IC sockets, voltage regulators, and the 100-pin connector. Wash

off the solder flux with alcohol or a similar solvent to get a clear view.

When the board is clean, use an ohmmeter to check for shorts between each
of the pins 1 through 100, then check the pin pairs for shorts (pins 1 and
51, and 50 and 100 are to be connected together). Check for shorts between
pins 1/51 (+8 vdc) and pins 50/100 (ground), pin 2 (+16 vdc) and ground, and
pin 52 (-16 vdc) and ground. Then check for shorts between the +5 vdc line
(Q2 or Q3 pin 3) and ground, the +12 vdc line (Q1 pin 3) and ground, and the
-5 vdc line (Q4 pin 3) and ground. Also, check for shorts between the three
voltage supplies. If all of these checks are proper, install the remainder
of the IC's per photo 5. DO NOT install the three MOS IC's at this time.

Board Cleaning

After completing all the soldering, scrub the trace side of the board with
alcohol or a similar solvent and a stiff brush. Carefully wash the component
side with alcohol and allow the board to dry. After washing and drying, in-
spect both sides of the board under a strong light for solder splashes,
bridges, etc. Remove any particles that may be lodged between the traces.
The board is now ready for checkout and use.

OPERATING INSTRUCTIONS

Power-Up Instructions

Remove all other boards from the system. Insert the MPU Board into its con-
nector with the system power off. Turn on the system power. Measure the
voltages at Q1 pin 3 (+12 vdc), Q2 and Q3 pin 3 (+5 vdc), and Q4 pin 3 (-5
vdc). Check the voltages at pins 28 (+12 vdc), 20 (+5 vdc), and 11 (-5
vdc) on the 8080A socket (B05). Check several other IC's for the proper
voltages, as a confidence builder. If all the voltages check out, turn off
the system power and remove the MPU Board. Insert the three MOS IC's into
their sockets, observing the special handling precautions for the MOS IC's.
Replace all the other boards into the system and place the MPU Board in its
connector. Apply power to the system.

Checkout Instructions

With the power applied to the system, check with an oscilloscope or a logic probe for clock pulses at pins 10 and 11 of A05 (8224), clock generator. If any problems arise, contact your nearest BYTE SHOP for assistance.
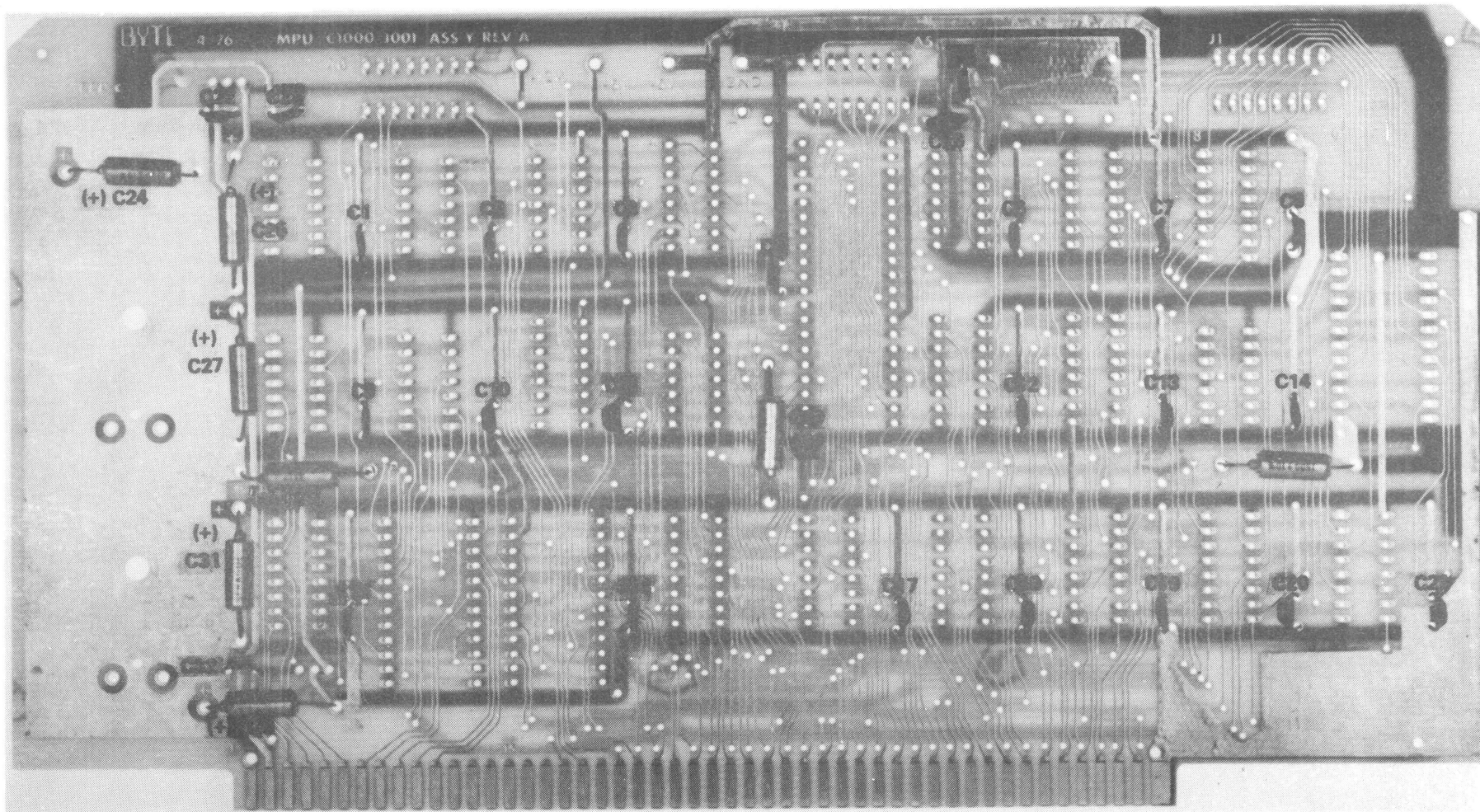
Install and solder all capacitors. Observe polarity with the eight 33-uf capacitors.
Polarity on the capacitors is indicated by an indentation around the cannister, a plus
sign on the cannister, a protrusion of metal on the end of the cannister, or a combin-
ation of these identification marks.

PHOTO 1
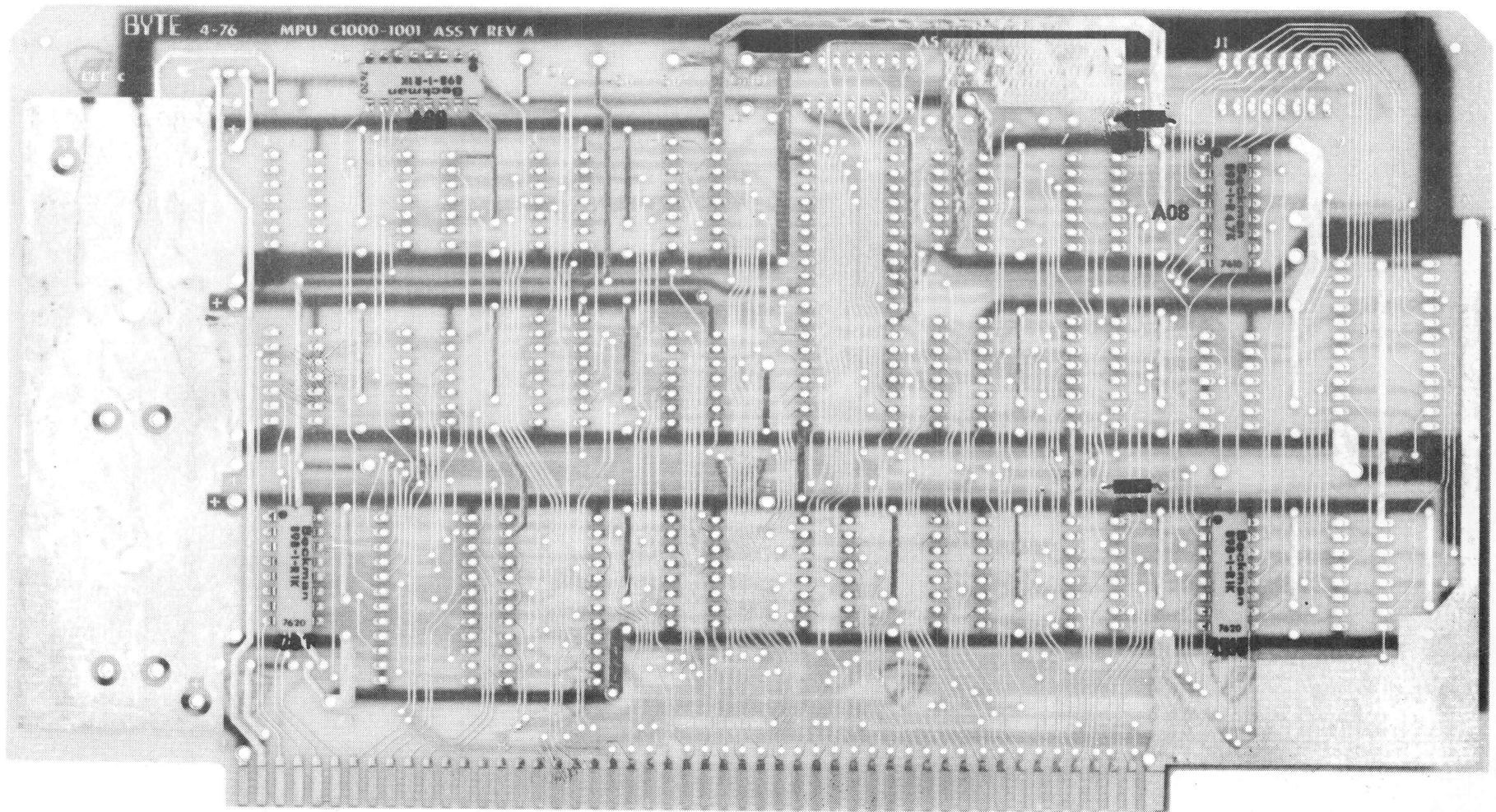
Install the diode, resistor, and resistor packs. The dot on the resistor packs represent pin 1. Pin 1 on the board is indicated by a slight protrusion (or knob) extending from the solder trace. Before soldering be sure pin 1 on the board mates with pin 1 on the resistor pack.

PHOTO 2

ADDENDUM

With the Q4 transistor positioned as indicated on
the board the center lead must be soldered in the
hole to the left of center and the left lead is
soldered in the center hole.

BYTE 4-76   MPU C1000-1001 ASS'Y REV A

HEAT SINK

Q1

Q2

Q3

6-32 x 1/4"
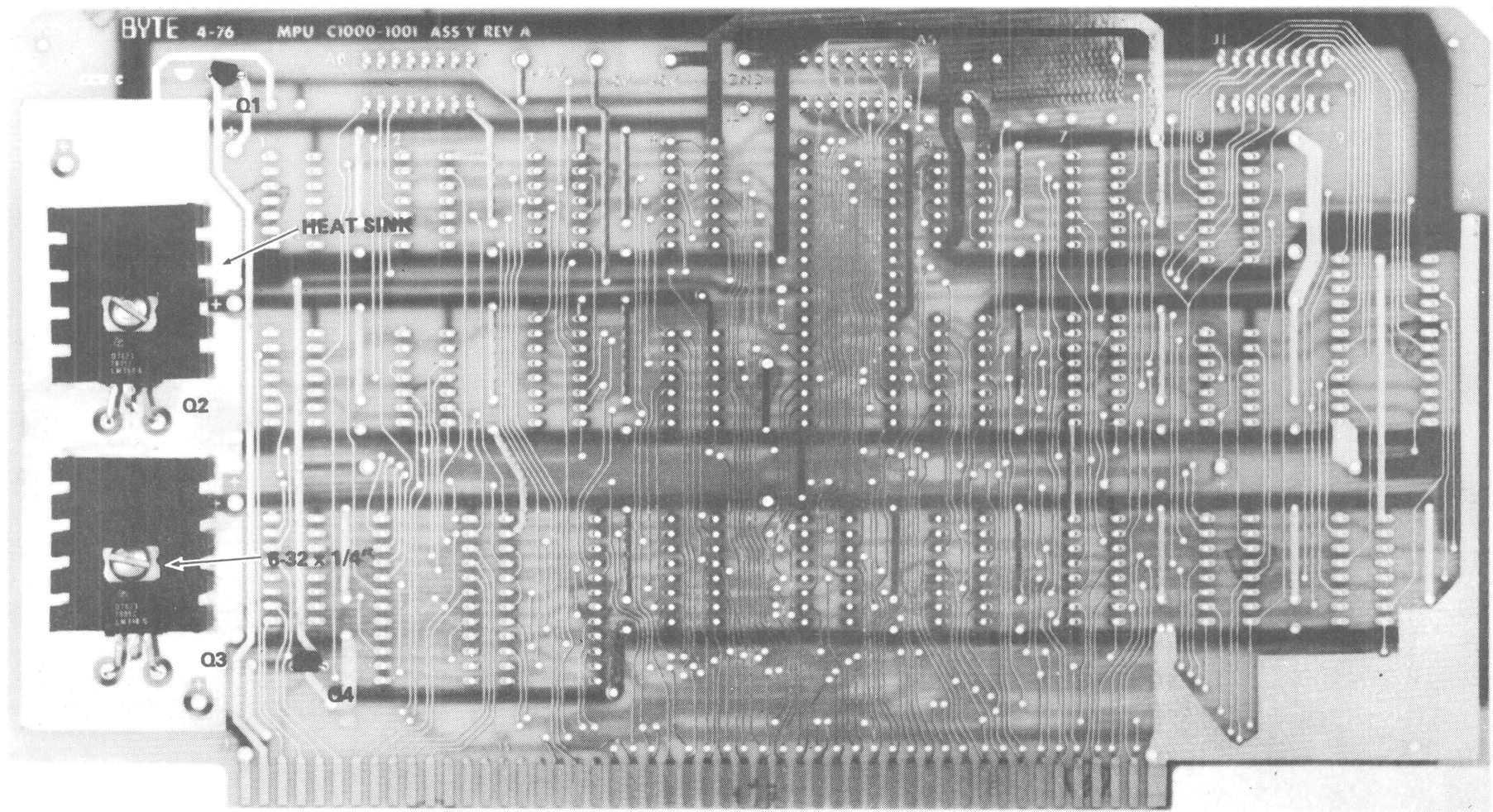
Install regulators. Use heat sink grease between the heat sink and board, and heat
sink and regulator. Install transistors, orienting the flat side of transistors as
shown on the board. BEFORE proceeding, insert the card into a machine and test for
the indicated voltages. Turn the machine off and remove the card.

PHOTO 3
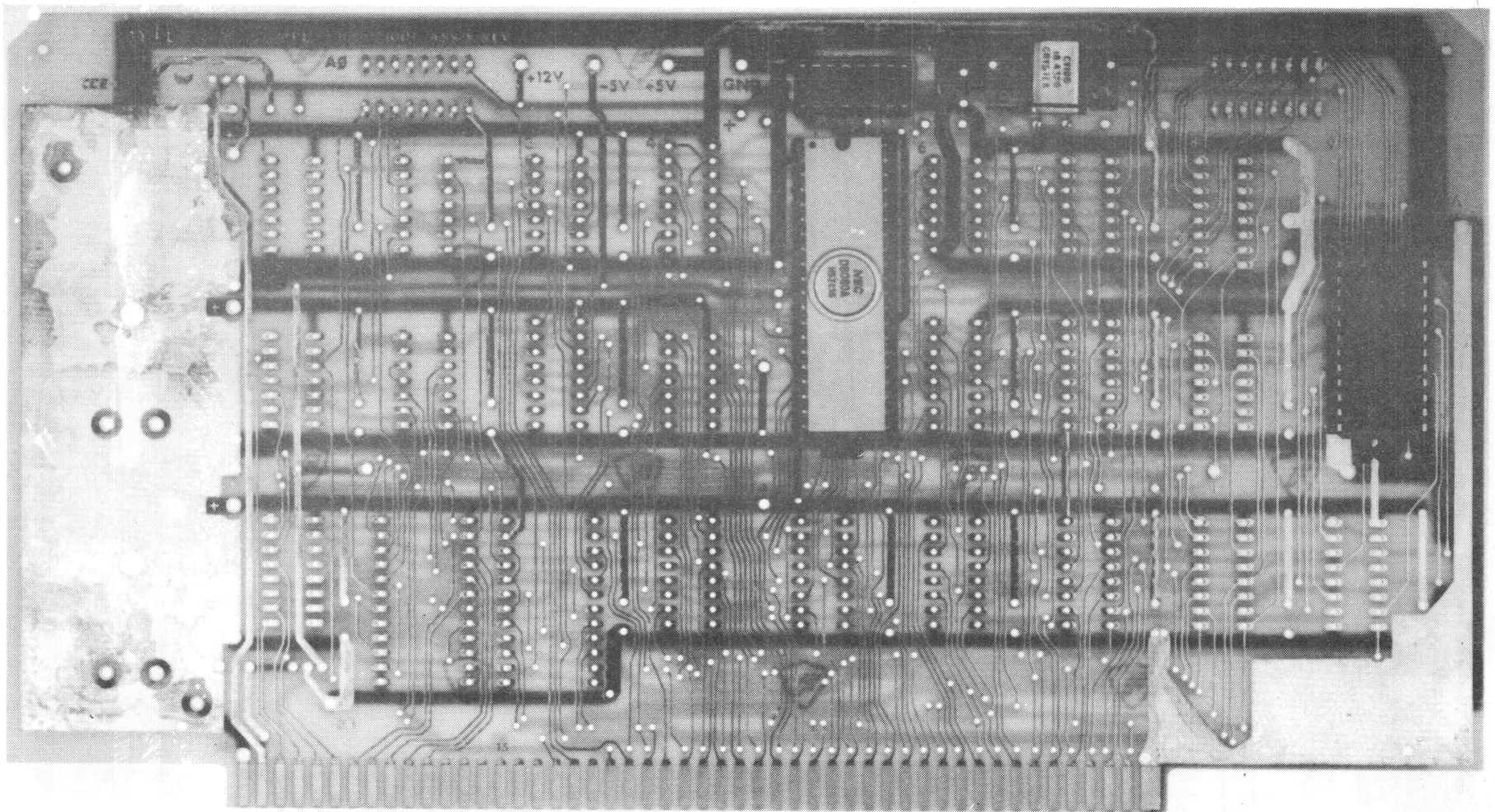
CAUTION: Solder the sockets in place. Do not insert the MOS chips. Observe pin 1 orientation as marked on the board and sockets. The sockets have a beveled corner opposite pin 1. Solder the crystal in place. Do not allow the crystal to touch the trace located right above it — this could cause a short in the board when power is applied.
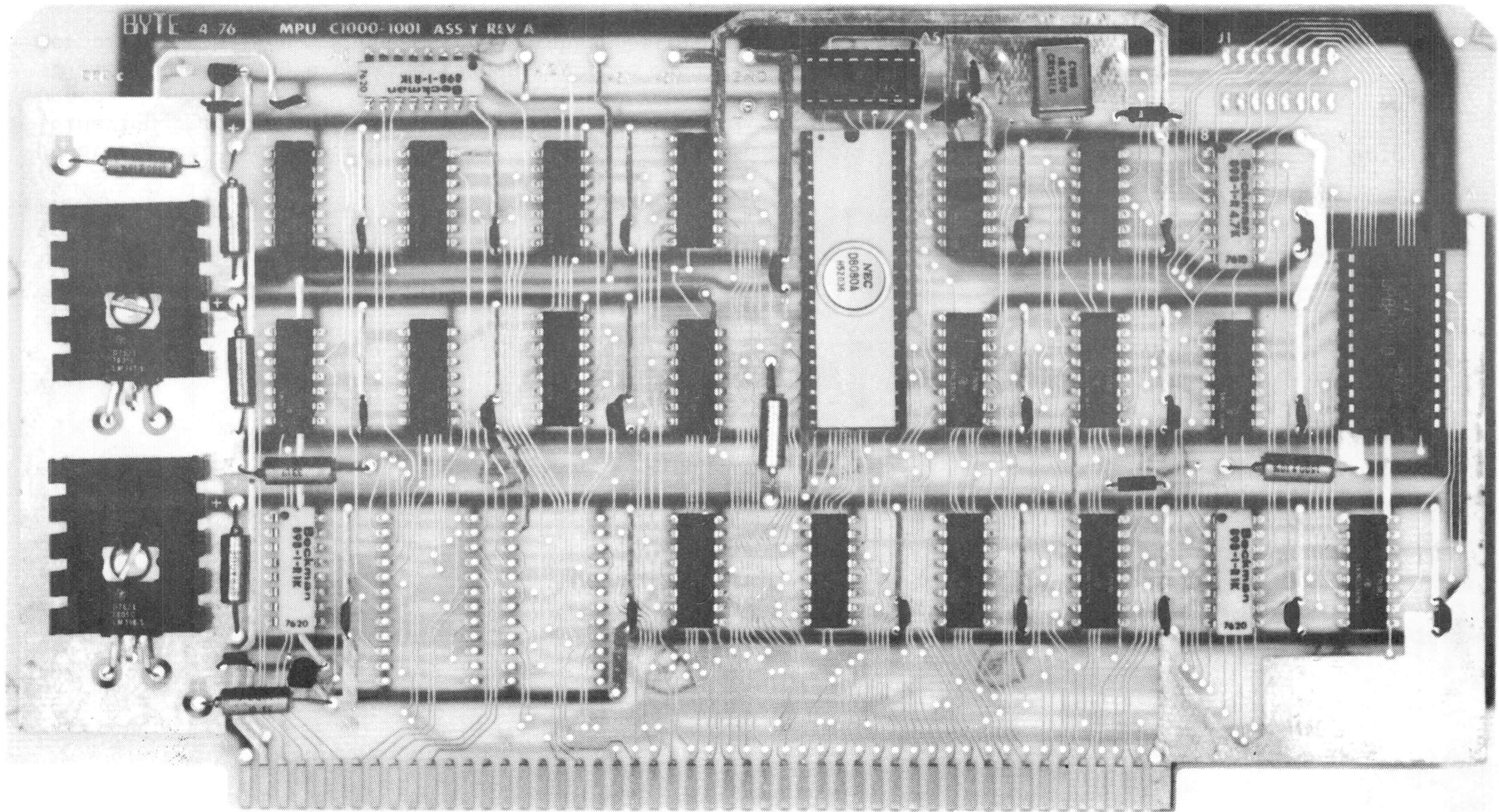
PHOTO 4
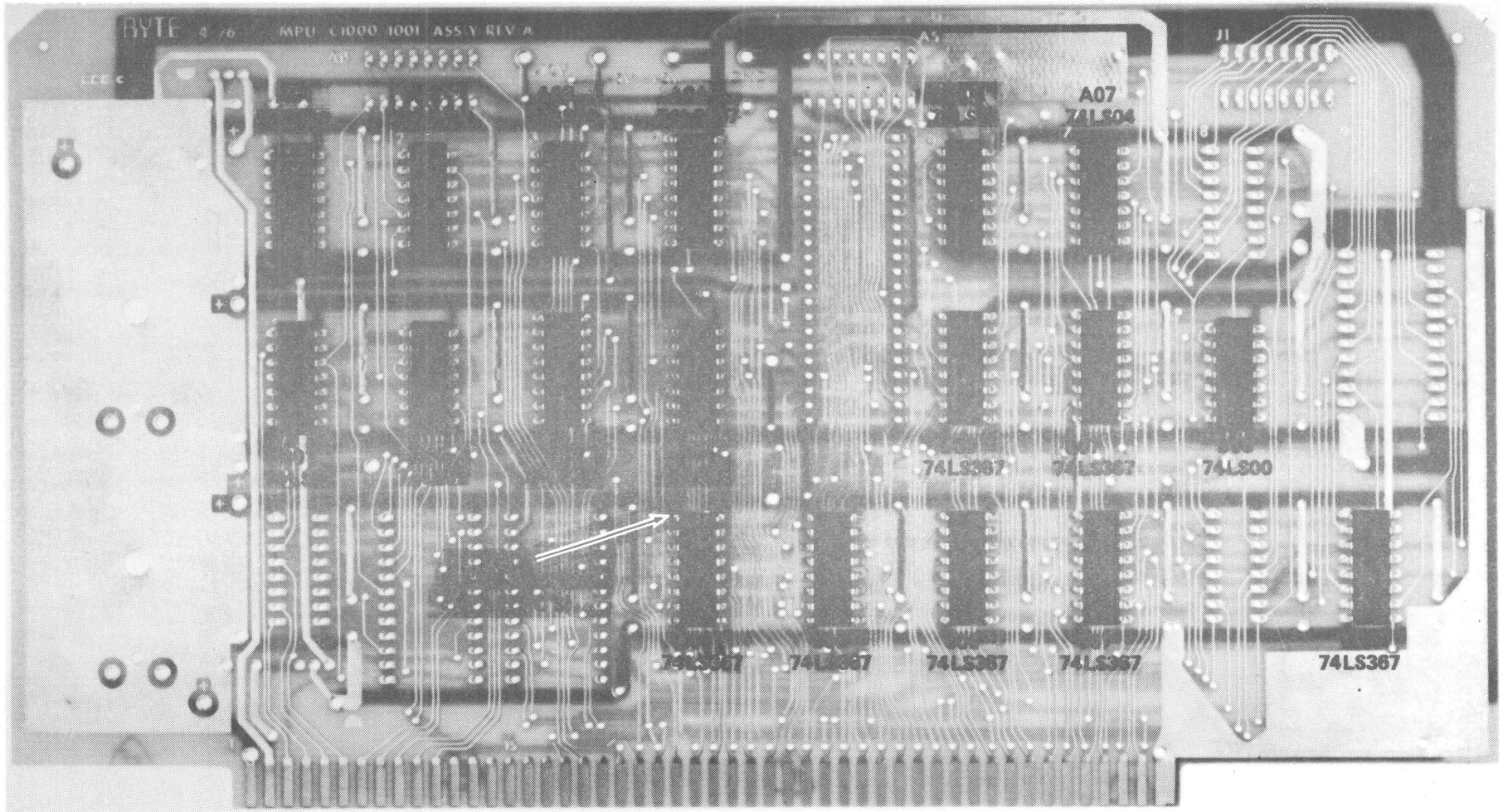
Observe pin 1 designations and install the remaining IC chips. Double check before soldering that the chip being soldered is the correct one for that position on the board.
NOTE: If soldering expertise is questionable it is recommended that sockets be used for all of the IC's. These may be purchased at the local Byte Shop.
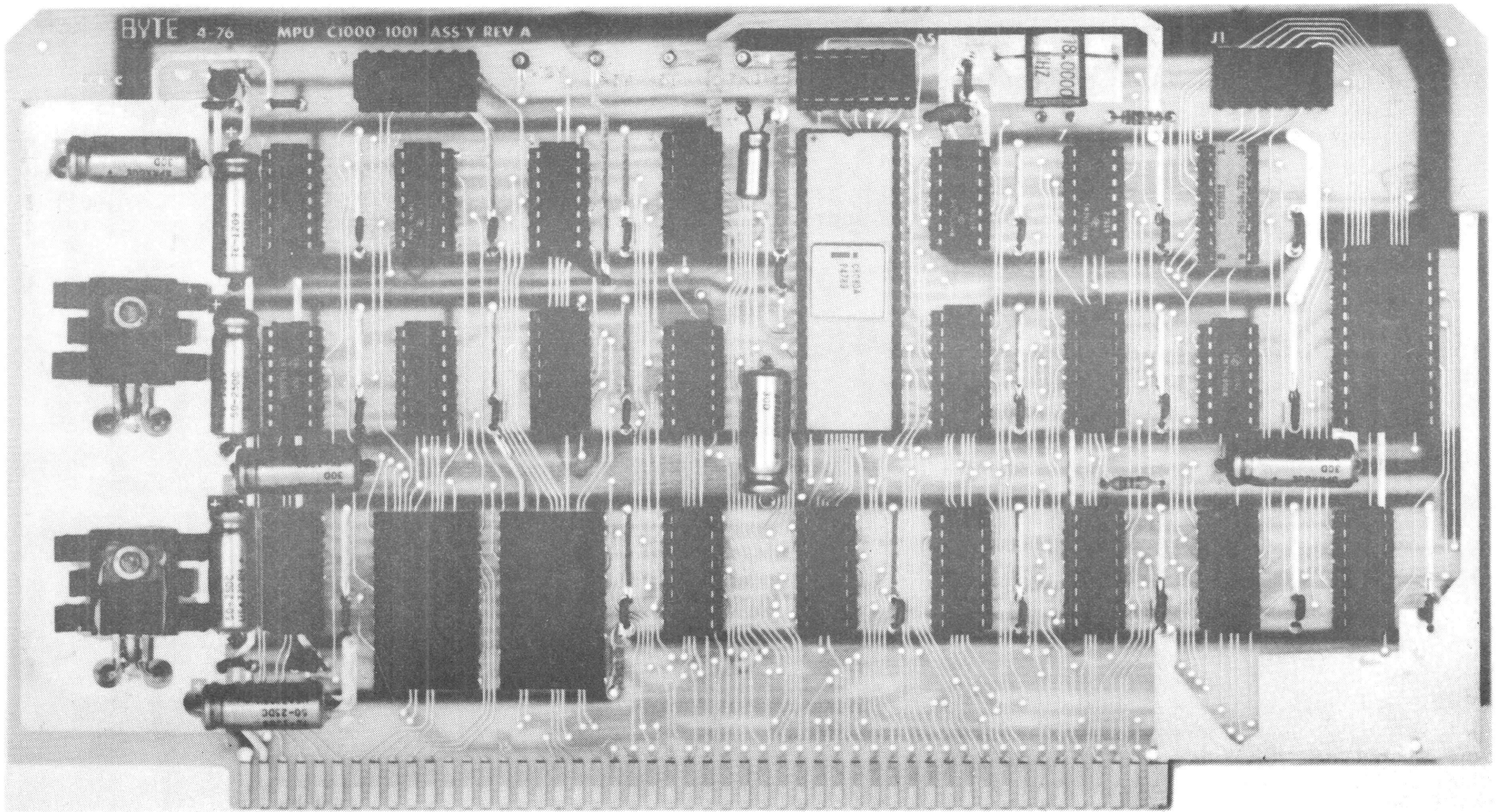
PHOTO 5

Turn the board over and clean all soldered connections with alcohol. Also check
carefully for solder bridges (solder between two connection points). Observe MOS
handling cautions and insert MOS devices into their sockets.
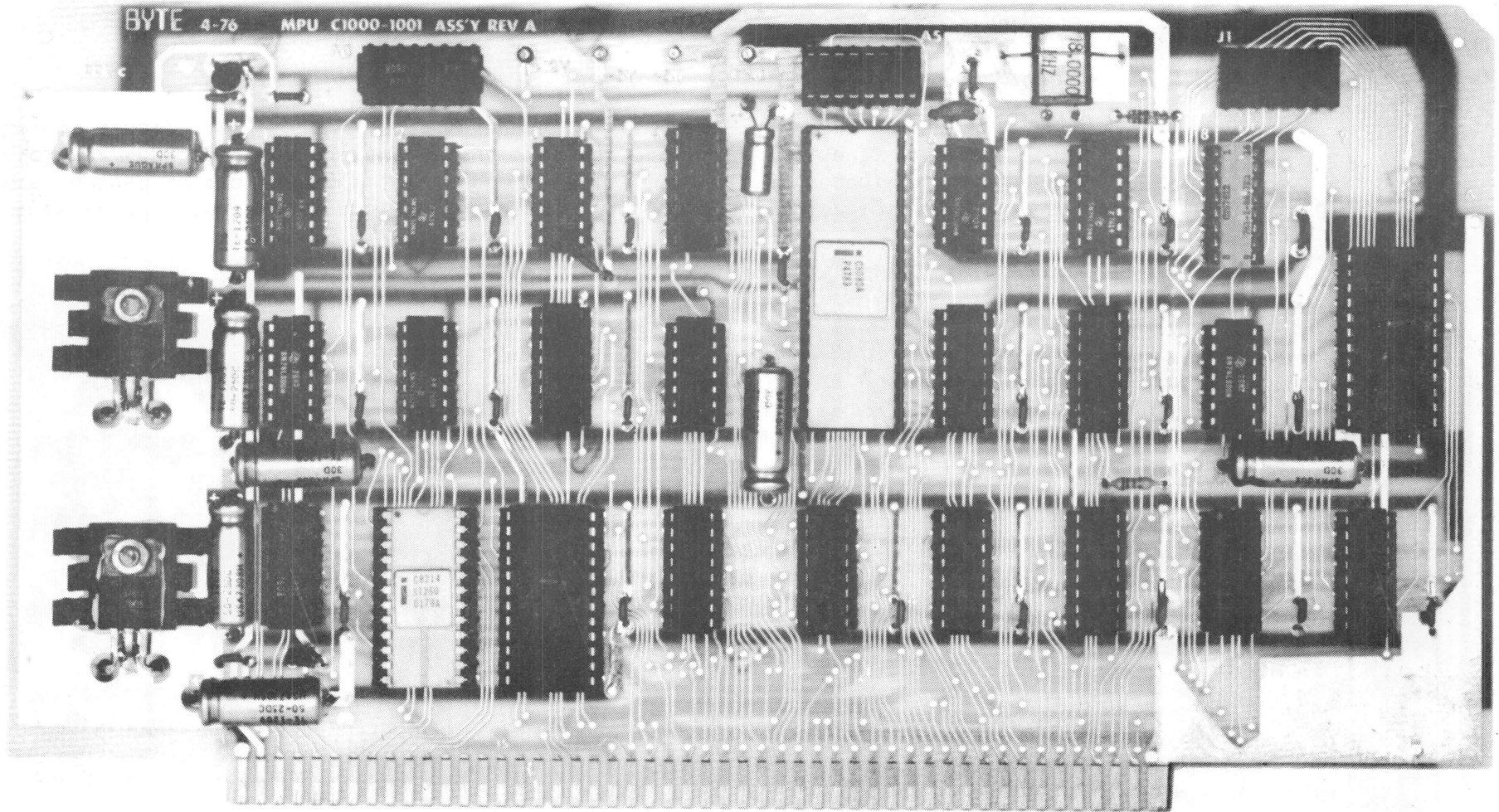
PHOTO 6

Sample board with sockets for all IC chips. The optional vector interrupt chips
were removed to show the complete socket. (The small silver capacitor at the top-
middle of the board was added by a customer for additional noise filtering on the
12-volt line.)

PHOTO 7

Sample board with all options installed.   The following options may be purchased at the Byte Shop: fourteen 16-pin sockets, nine 14-pin sockets, two 24-pin sockets, one Type 8214 IC, one Type 8212 IC.

PHOTO 8

P.C.B. ASSEMBLY PARTS LIST
Drawing 1000-1001 Rev. A

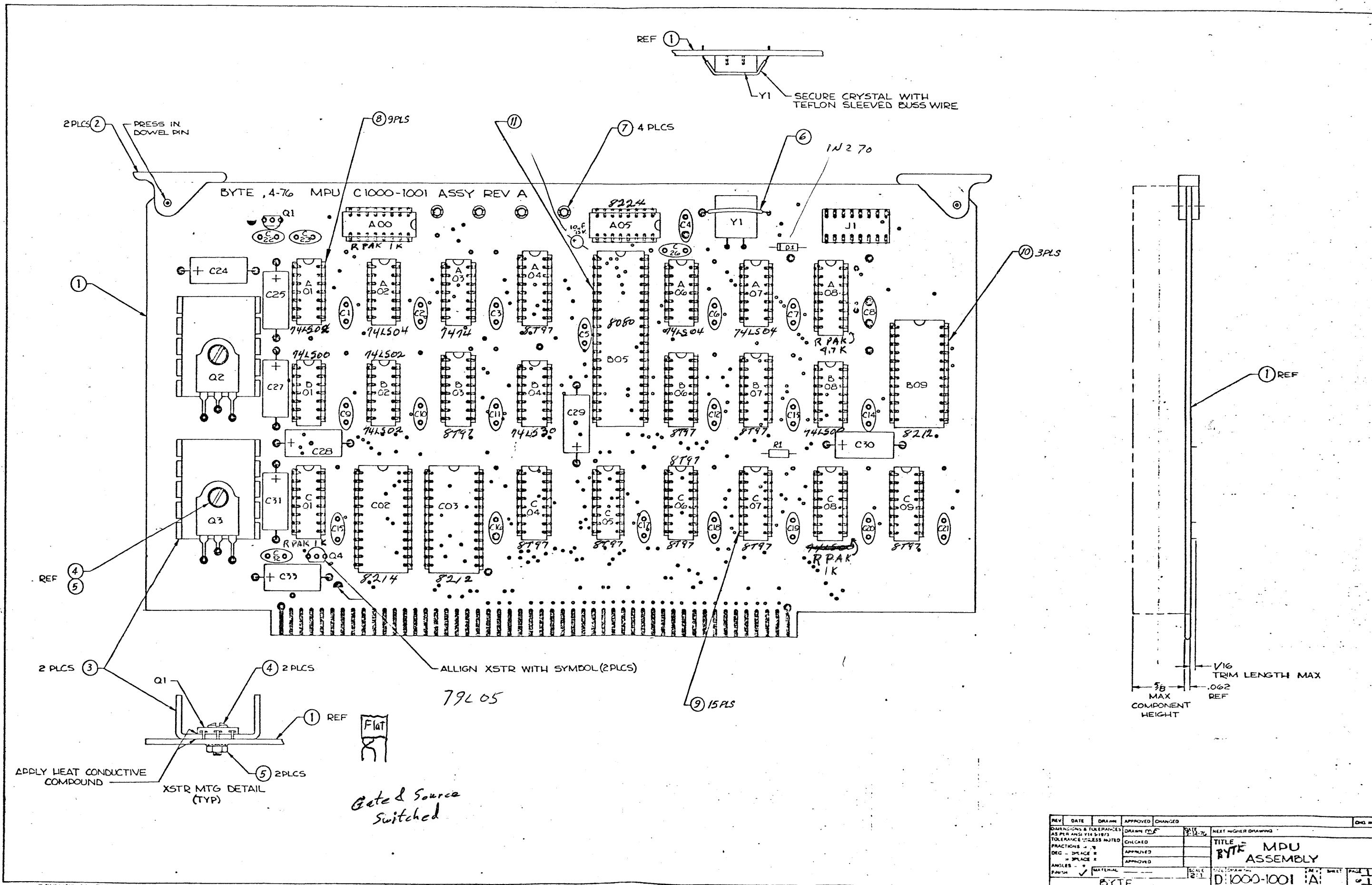| ITEM	QTY	PARTS DESCRIPTION
1	1	P.C. Board, MPU, 1000-1001A
3	2	Heat Sink, 1.2X1"
4	2	6-32X3/8 BHMS
5	2	6-32 Hex Nut
	2	#6 Internal Lock Washer
9	1	I.C. Socket, 16 Pin, J1
10	1	I.C. Socket, 24 Pin,
11	1	I.C. Socket, 40 Pin,
13	1	I.C. 8080A, B05
14	1	I.C. 8224, A05
15	1	I.C. 8212, B09
17	9	I.C. 74LS367, A04, B03, B06, B07, C04-C07&C09
19	2	I.C. 74LS00, B01&B08
20	2	I.C. 74LS02, A01&B02
21	3	I.C. 74LS04, A02, A06&A07
22	1	I.C. 74LS74, A03
23	1	I.C. 74LS30, B04
24	3	Resistor Pack, 1K, ¼w, 5%, C01, C08&A00
25	1	Resistor Pack, 4.7K, ¼w, 5%, A08
28	1	Crystal, 18.432MHz, Y1
29	1	Transistor, 78L12, Q1
30	2	Transistor, 7805, Q2&Q3
31	1	Transistor, 79L05, Q4
32	24	Capacitor, .1uF, 50V, C1-C23 & C32
33	8	Capacitor, 33uF, 20V, C24&C25, C27-C31, C33
36	1	Capacitor, 10pF, C26
38	1	Resistor, 1K, ¼w, 5%, R1
39	1	Diode, IN914, D1
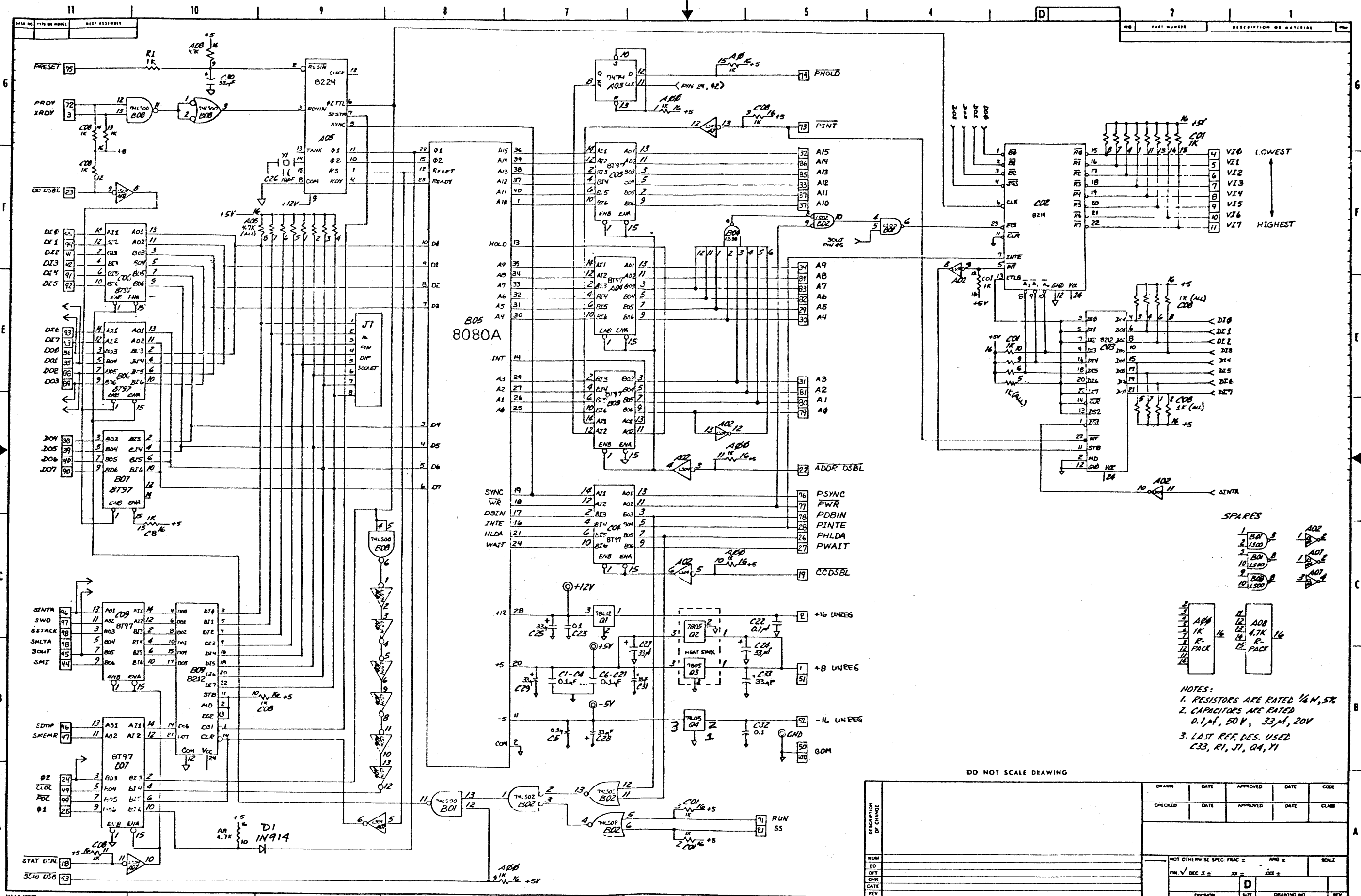
8080A (B05)

B224 (A05)

B214 (C02)

B212 (B09)

NOTES:
1. RESISTORS ARE RATED 1/4 W, 5%
2. CAPACITORS ARE RATED 0.1 µf, 50V, 33 µf, 20V
3. LAST REF. DES. USED C33, R1, J1, Q4, Y1

DO NOT SCALE DRAWING

SPARES

LOWEST
VI0
VI1
VI2
VI3
VI4
VI5
VI6
VI7
HIGHEST

PRESET
PRDY
XRDY
DO DSBL
PHOLD
PINT
PSYNC
PWR
PDBIN
PINTE
PHLDA
PWAIT
ADDR DSBL
CCDSBL
RUN
SS

+16 UNREG
+8 UNREG
-16 UNREG
GND
COM

REF ①

Y1 — SECURE CRYSTAL WITH
TEFLON SLEEVED BUSS WIRE

2 PLCS ② — PRESS IN DOWEL PIN

⑧ 9 PLS

⑪

⑦ 4 PLCS

⑥

1N270

BYTE , 4-76 MPU C1000-1001 ASSY REV A

Q1

A00   RPAK 1K

8224   A05   C4   Y1   D1   J1

10μF 13V   C26

⑩ 3 PLS

① REF

①

C24   + C25   A Q1   A Q2   A 03   A 04   8080   A 06   A 07   A 08   RPAK 4.7K

74LS02   74LS04   7474   SoT97   B05   74LS04   74LS04

74LS00   74LS02

Q2   + C27   B 01   B 02   B 03   B 04   C29   B 07   B 08   B09

74LS02   8T97   74LS30   8T97   8T97   74LS00   C30   8212

+ C28

8T97

C31   C 01   C02   C03   C 04   C 05   C 06   C 07   C 08   C 09   R1

Q3   RPAK 1K   Q4   8T97   8T97   8T97   8T97   RPAK 1K   8T97

REF ④ ⑤

+ C33   8214   8212

ALLIGN XSTR WITH SYMBOL (2 PLCS)

79L05

⑨ 15 PLS

2 PLCS ③

④ 2 PLCS

① REF

Flat

Q1

APPLY HEAT CONDUCTIVE COMPOUND

⑤ 2 PLCS

XSTR MTG DETAIL (TYP)

2 PLCS ③

REF ④ ⑤

Gate & Source Switched

⅝ MAX COMPONENT HEIGHT

1/16 TRIM LENGTH MAX

.062 REF

REV	DATE	DRAWN	APPROVED	CHANGED			CHG NO

DIMENSIONS & TOLERANCES AS PER ANSI Y14.5-1973
TOLERANCE UNLESS NOTED
FRACTIONS ±
DEG - 2 PLACE ±
3 PLACE ±
ANGLES ±
FINISH ✓
MATERIAL

DRAWN   DATE 4-14-76
CHECKED
APPROVED
APPROVED

NEXT HIGHER DRAWING

TITLE BYTE MPU ASSEMBLY

BYTE

SCALE 2:1   D 1000-1001 A   SHEET 1 PAGE 1