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po box 6528 denver, colorado 80206 (303) 777-7133

32K Memory Board

DIGITAL GROUP 32K MEMORY BOARD

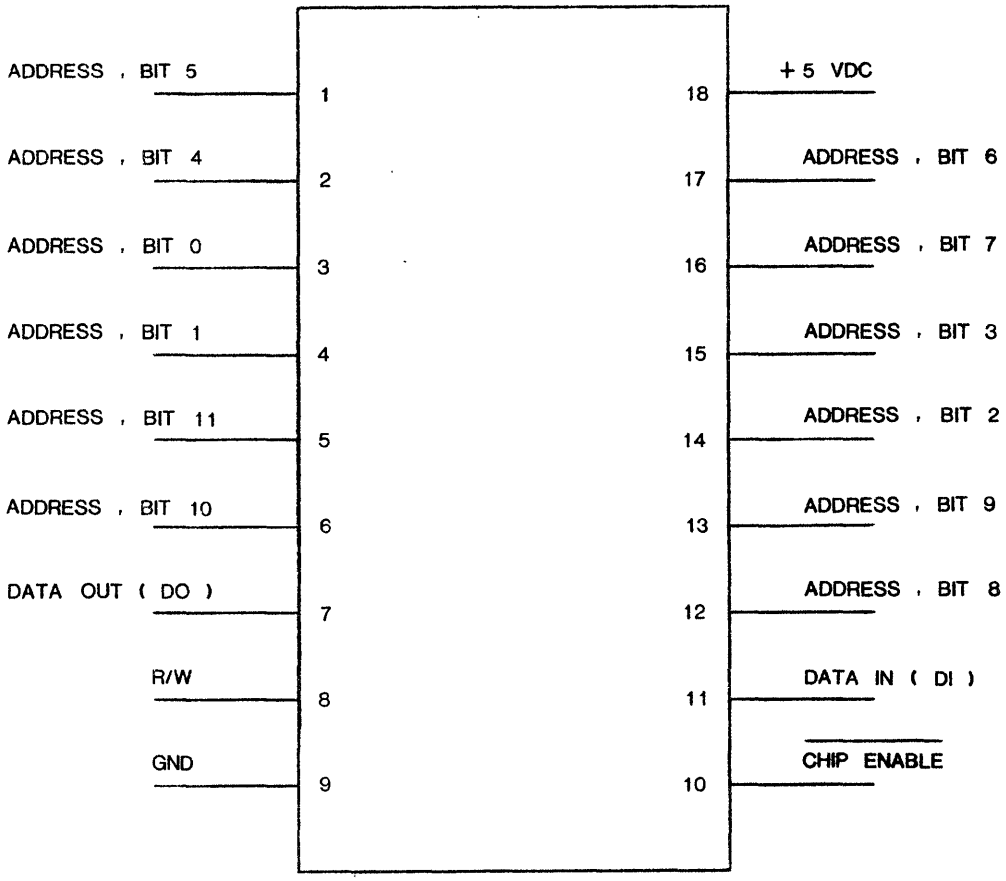
Introduction

Well, here it is! 32K on one board, a full 64K on just two.

The Digital Group 32K Memory Board is designed around a 4K × 1 Static RAM chip using a single +5V DC power supply. It is completely static, needing no clocks or refreshing. It is TTL compatible and tri-state outputs make it data bus compatible.

The memory IC is packaged in an 18-pin DIP. Each chip has 12 address lines, separate data in (DI) and data out (DO) lines, a READ/WRITE (R/W) line, a chip enable (CE) line and voltage supply pins (+5V DC, GND).

The 32K board provides on-board jumpering for allocating the board as upper or lower memory (0 - 32K or 32K - 64K) and BANK ENABLE jumpering for each of the eight banks (4K × 8 bits) on the memory board. The 32K board may be populated in increments of 4K bytes by adding eight memory IC's. In addition, the 32K board provides eight buffered DI lines and eight DO lines for each bank, an address decoding network for bank selection (CHIP ENABLE), a R/W line and a ROM enable line. The pinout for the TI4044 and National 5257 4K × 1 Static RAM chip is shown below.



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Circuit Description

The memory configuration of the 32K memory board is similar to that used in the Digital Group 8K × 8 memory boards. To obtain 8-bit bytes or data words used by the CPU, memory chips are grouped by rows (or banks) of eight. By tying the CE lines of each chip in a bank, the memory IC's of a bank are enabled simultaneously. Each chip of a particular bank provides one bit of an 8-bit word, i.e., IC00 provides BIT 0 (LSB), IC01 provides BIT 1 (LSB + 1) and so on, with IC07 providing BIT 7 (MSB).

Refer to the schematic and parts layout diagram for IC numbering and placement.

Twelve address lines running in common to every RAM chip (all 64) permit access to each bit (4096) in each RAM chip. Thus each bank of eight memory IC's contains 4096 bytes; each chip has 4096 addressable locations and each bank has eight bits. There are a total of 16 address lines running to each memory board, allowing 65,536 addressable memory locations. On the 32K board, 12 address lines go to each memory chip (as previously mentioned) inverted by IC85 and IC88 (7404). The other four lines are used to select one of the eight banks, and to allocate the memory to lower (0 - 32K) or upper (32K - 64K) on the 32K memory board. These four address lines (MSB - 3, MSB - 2, MSB - 1, MSB) are input to IC80 (7442) which selects the desired bank by making one bank's CE line go low. When the CE line is brought low by the bank select circuitry and jumpers, it allows the chips in the enabled bank to be read from or written into, depending on the condition of the R/W line .Only one CE line from IC80 is brought low. A high condition on the R/W line allows the data of an enabled bank to be read by the CPU from the DO lines of that bank. The particular byte read from memory would be selected by the address present on the address lines to the enabled bank of 8 RAM chips. During a WRITE cycle, when the R/W line is low, the DO lines would be in a high impedance state. Data would be written into a selected bank through the DI lines. The exact location within the 4K bank would again be determined by the address presented on the address lines. On a bank which is not enabled, the CE line is high and the chips are in a standby condition, with both the DI and DO presenting high impedance outputs.

IC00 - IC77 are the memory chips. The first digit refers to the bank of memory, and the second digit is the chip's bit location. For example, IC47 is the bit 7 RAM in bank 4.

IC86 and IC87 (74125) are bus drivers for the eight data input lines to memory. IC83 and IC84 (74126) are bus drivers for the eight data output lines from memory going to the CPU. IC81 (7430) is an eight input nand gate, which tri-states the memory board's output bus if ROM is enabled or if the memory board is not selected. IC82 (7400) is used to buffer the R/W line which goes to all 64 memory chips, and to allocate the memory on the board. The 32K card may be intermixed on Digital Group systems with our 8K memory cards. The memory card is rated at 450 ns, so the CPU operates at full rated speed. The card requires 4 amps @ +5V DC.

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Assembly

Estimated Construction Time: 2 - 6 hours

To build The Digital Group 32K Memory Board you will need the following tools and equipment:

Fine tipped low wattage soldering iron (approximately 15 watt)
Solder—60/40 resin wire solder, 29 gauge (approximately)
Do not use acid core solder!
Diagonal cutters—small micro shear type preferred
Long-nosed pliers
Flux remover or alcohol
Small brush
Volt-ohm meter

Refer to the parts placement diagram during construction.

Before beginning to mount and solder components, inspect the Memory Board. **The side from which the components are mounted has the Digital Group label on the bottom left portion of the board.** Compare the areas where IC sockets will be inserted with the layout to see that there are no shorts occurring between either the traces leaving the IC or the IC pads or holes in which the IC's are mounted. While plating errors like this are a rare occurrence and The Digital Group tries to inspect and maintain the quality of its printed circuit board, once the IC sockets are inserted it is very difficult to find such a problem.

The sockets should be mounted as close to the board as possible. Do not bend the leads of the IC sockets excessively before soldering, as they may break off at the base of the socket.

1. ☐ Make sure you have all of the components shown on the parts list.

2. ☐ Insert and solder the 16-pin IC socket for IC80 making sure the notched end of the socket is near the top of the board, away from the edge connector.

3. ☐ Insert and solder the eight 14-pin IC sockets (IC81 through IC88). This can be done one socket at a time or all eight at once. These sockets are located in the middle of the board.

4. ☐ Insert and solder the 64 18-pin IC sockets. (Only 32 sockets and RAM chips are supplied with a 16K Memory Board. The 16K version uses IC00 - IC37.)
   Caution: The socket traces are very close and a careful job at this point may save you hours of troubleshooting time!

5. ☐ (This step applies only when assembling a 16K board.) Insert and solder the 5.6K resistor pack on the upper center of the board. Note the dot on one end. This end *must* be oriented toward the left (nearest IC80). This resistor pack is not supplied with a fully populated 32K Memory Board.

6. ☐ Insert and solder the 21—.01 mfd disc bypass capacitors as indicated on the parts placement diagram. Clip and save the excess leads.

7. ☐ Insert and solder the 1 mfd tantalum capacitor. Note that the + (or striped) end faces left. Clip the excess leads.

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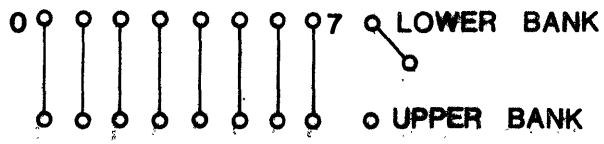
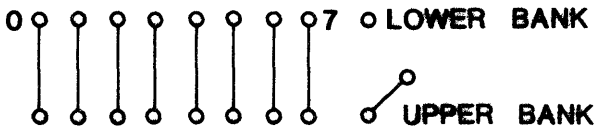
8. ☐ This memory board may have up to 32K of memory inserted. This 32K of memory may be at either the bottom end of memory (most common) or the high end (32K to 64K).

The nine jumpers for the low end assignment would be:

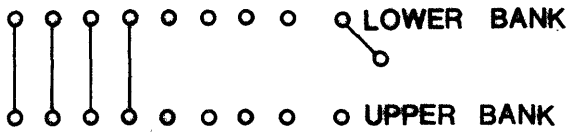


The 32K to 64K assignment would be :



The eight leftmost jumpers on the board indicate to the memory bus control logic which of the memory banks is being utilized by this board. Should a board be utilized with less than a complete complement of memory IC's, the missing IC banks would have their respective jumpers omitted. The left to right orientation of the jumper corresponds to the bank 0 through 7 assignment.

EXAMPLE:
32 IC's are to be used as the 0 - 16K memory of a system. The IC's will be plugged into IC00 through IC37 sockets. The jumpers would be connected as follows:



9. ☐ Use the leads clipped from the bypass capacitors in Step 6, or wire of approximately 28 - 30 gauge, to connect the jumpers according to the scheme as presented above. Solder the jumpers and clip off the excess leads.

10. ☐ At this point measure the resistance between pin 1 (+5V DC) and pin 2 (ground) on the edge connector with an ohmmeter. If there is a low resistance, this indicates a bad capacitor or a solder bridge somewhere on the board.

11. ☐ Insert IC80 through IC88 in the center of the board. Again measure the resistance between connector pins 1 and 2. Reverse the meter leads and compare readings with the reverse polarity. The resistance should be somewhat lower in one direction than the other, but not zero ohms. The same resistance in each direction indicates a reversed IC.

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Memory Insertion and Diagnosis

The memory IC's are essentially connected in parallel by the 12 address lines, and therefore, can represent a considerable "guessing game" if all of the memory chips were to be inserted along with one defective or shorted chip. A preferred technique is to insert a bank at a time and test with New Memory Test #2 (standard for 1024 TVC Z-80 Operating System; optional cassette from DGSS for 512 TVC Z-80 Operating System). If the memory test stops, indicating an error, the board and IC numbers displayed will be erroneous, but usable with a conversion. This is necessary since the memory test routines normally use 8K memory boards and define IC and board numbers according to normal 8K memory board boundaries. The 32K board replaces four Digital Group 8K boards, and so contains four standard board boundaries.

1. ☐ Start by inserting IC00 through IC07 in the sockets at the top left of the board as shown on the layout, with the notch or pin 1 end away from the connector. (The bank and IC numbering scheme of the Digital Group 32K Memory board is not the same as the Digital Group 8K memory board!). Insert the board into your CPU cabinet and run Memory Test #2.

2. ☐ After successfully testing the first bank of memory with the memory test routine, insert the board into the CPU cabinet and test the other IC banks in the same manner.

3. ☐ Once the board is populated, it is advisable to run an extensive memory test (2-3 days continuously). Use both New Memory Test #2 and #3. Chip failure (fallout) occurs most frequently in the initial hours of operation. Chips which are temperature sensitive also will fail or be indicated by an extensive memory test.

4. ☐ The IC's used on the memory board can also be rather sensitive to the power supply voltage. To insure that your system remains error-free, adjust the +5 volt supply to measure between +4.5 and +5 volts at the memory supply bus on the 32K Memory Boards (between pin 1 and pin 2). Note that additional cooling often solves other strange memory problems.

Converting 8K Memory Test Notation to 32K Notation

When the New Memory Test #2 finds a missing or bad IC, or unsoldered or bent pin, the board number (0 - 7)and the IC number (00 - 77) will be printed on the screen, as "Board 3 IC15". Since the 32K memory board replaces four 8K memory boards, a translation of the number is necessary. To locate a bad IC on the 32K memory board, follow these steps.

Refer to Figure 1 and the layout diagram. Use the board number printed on the screen to determine whether the bad IC is in the upper or lower 32K of memory. "Board 3" indicates the lower 32K board as shown. Each board of 8K memory has been replaced by two banks of IC's on the 32K board. The figure shows this relationship. The first digit of the IC number determines which of the the two banks contains the bad IC. When the first digit is 0 - 3, the bad IC is in the first bank; if the first digit is 4 - 7, the bad IC is in the second bank. The second digit of the IC number gives the location (0 - 7) in the bank. The example, "Board 3 IC51", refers to IC71 on the lower board.

Here are some examples of adapting the Memory Test numbering to 32K memory.

1. "Board 0 IC27" is IC07 on the lower 32K board.

2. "Board 7 IC53" is IC73 on the upper 32K board.

3. "Board 5 IC27" is IC27 on the upper 32K board.

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Parts List

		Digital Group Part #
TTL IC's		
1	7400	075 - 000
2	7404	075 - 004
1	7430	075 - 012
1	7442	075 - 016
2	74125	075 - 031
2	74126	075 - 054
Memory IC's		
64	TI 4044 National 5257 or equivalent (only 32 are provided with 16K board)	072 - 005
Miscellaneous		
21	.01 mfd disc capacitors	014 - 002
1	1 mfd tantalum capacitor	010 - 000
8	14-pin sockets	060 - 001
1	16-pin sockets	060 - 002
64	18-pin sockets (only 32 are provided with a 16K board)	060 - 003
1	10-pin SIP 5.6K resistor pack (only supplied with a 16K board)	008 - 004
1	Printed circuit board	090 - 045
1	32K Memory Board documentation	298 - 071
1	36-pin dual edge connector	080 - 001

	Kit	Assembled
32K Memory Board	800 - 056	810 - 034
16K Memory Board	800 - 055	N/A
16K to 32K Upgrade (consists of 32 additional RAM chips and sockets)	800 - 057	N/A

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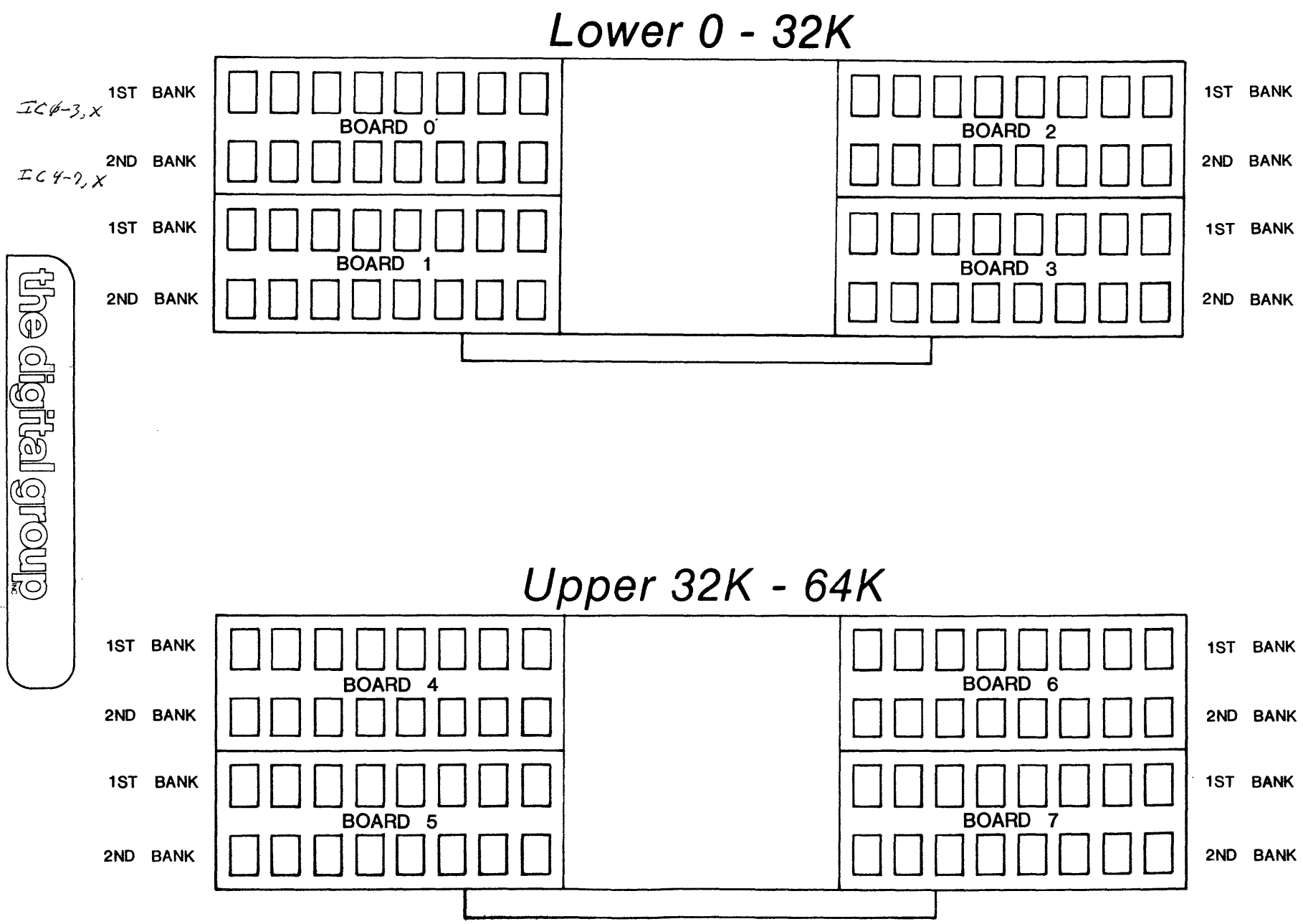
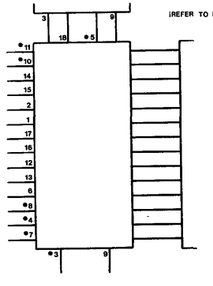


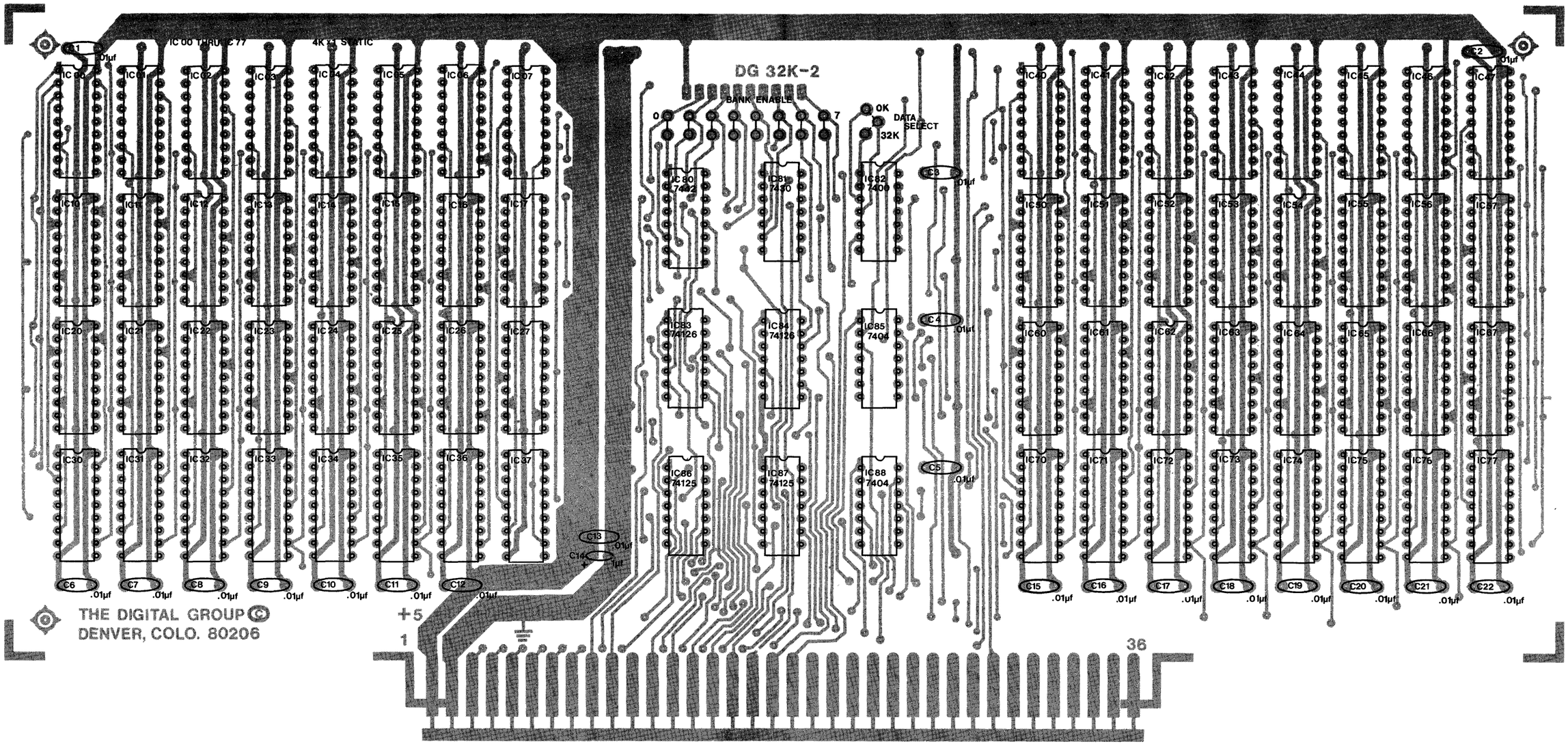
FIG. 1

THE DIGITAL GROUP
32 KILOBYTE MEMORY

MEMORY CHIP PIN NUMBERS AS SHOWN
ARE FOR T.I. TYPE 4044, NATIONAL TYPE MM5257 OR EQUIVALENT.

FOR ASSEMBLIES USING EMM TYPE 4801A
PINS NOTED WITH ASTERISKS(*) ARE AS FOLLOWS:




DG 32K-2
BANK ENABLE
0
7
OK
DATA SELECT
32K
IC80 7442
IC81 7430
IC82 7400
IC83 74126
IC84 74126
IC85 7404
IC86 74125
IC87 74125
IC88 7404
C1 .01uf
C2 .01uf
C3 .01µf
C4 .01µf
C5 .01µf
C6 .01µf
C7 .01µf
C8 .01µf
C9 .01µf
C10 .01µf
C11 .01µf
C12 .01µf
C13 .01µf
C14 1µf
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