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PROGRAM AUGAT

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ABSTRACT

A program has been written and used for over a year which allows the engineer to more easily design, document and build hardware on the Augat 8136-RG4 logic card. Input is via a card deck of control cards interspersed with data cards. A description of the control and data cards, their function and operation is given, as well as a simple example.

INTRODUCTION

The AUGAT program is designed to help the engineer develop a good design of a circuit consisting of integrated circuits on an AUGAT 8136-RG4 wire wrap card.

The AUGAT 8136-RG4 card consists of 60 sockets in a 5 x 12 array, and 120 edge connectors. The Augat card is 1/8 inch thick, and is 7-3/8 inches wide by 7 inches long. The back of the card contains an array of wire wrap pins 1/2 inch long. Figure 1 illustrates the card.

Each card contains a ground (GND) and Vcc (+5 V) printed circuit plane on opposite sides of the card.

Each socket consists of an array of 18 wire wrap pins and 16-pin I. C. Sockets, at normal spacing for the standard DIP package. The two additional pins are a local source of +5 V and GND. Any socket may be loaded with any 4,6,8,14 or 16-pin DIP, or discrete components. The program has facilities for processing 8-, 14-, and 16-pin DIP automatically.

The edge connector consists of 60 printed fingers on each side of the board, and a key slot. There is also an array of 120 wire wrap pins, numbered 1 to 122, with pins, numbers 58 and 119 (corresponding to finger location at the key slot) missing.

CIRCUIT DESCRIPTION

A circuit is described in terms of signal names and socket/edge locations. The basic description may be modified by additional commands, described below.

A signal is an eight character name, which may contain imbedded blanks. Any character string may be used for a signal name, subject to two conditions: 1) a name consisting of all blanks is ignored; 2) a signal which has the character "$" as the first character is treated specially. Otherwise identical names with imbedded blanks in different position are treated as different names. Thus, "SIGNAL1" is considered by the program to be different than "SIGNAL 1".

Any signal with a "S" prefix is considered to be the same as the identical signal without the $, and with an appended blank: "$" is merely a code for a signal source, and the pin to which it is applied is so flagged. (Various of the output documents will have the "$" flag shown to aid the engineer.) Thus, "$CLOCK1‸" is identical to "CLOCK1‸‸".

A physical component (I.C., edge pin group) is first invoked by the appropriate command, and then described by the appropriate number of cards containing up to ten names each, in 10A8 format. This is illustrated in Appendix 1.

A component may, if desired, be defined more than once (provided this is done cautiously). In this case, new signals override old signal definitions, but blank signals will leave the previous definition unchanged. Similarly, a blank input may be overridden by a BUSS command to connect +5 V and GND to an I.C.

(NOTE: The program will become confused if a signal is redefined after a LINK command has been issued.)

Successive signal names will be allocated to successive I.C. pins in prevailing I.C. mode (8-PIN, 14-PIN and 16-PIN). Thus in 14-PIN mode, the eight signal name will correspond to pin 8 of a 14-pin I.C., or to pin 10 of that socket.

WIRE ROUTING

Upon recognizing a LINK command, AUGAT will proceed to connect all pins with the same signal, and perform routing on the interconnections. This is done in four passes, illustrated in Figs. 2 through 5.

Essential to this description is the concept of signal strings. A signal string consists of a list of one or more pins associated with a given signal name, linked together in the order in which they will be wired. The result of a LINK command is one separate signal string for each signal defined.

Routing Pass 1: (Fig. 2) for each of the 18-pin socket pins which is the start of a signal string, the end of that string is found, and linked to the next signal string (identical as to signal). This is iterated until each socket contains only one signal string for each unique signal. At this point GND and +5 V are linked for each socket.

Routing Pass 2: (Fig. 3) for each of the five sockets in a column (e.g., numbers 1,13,25,37 and 49) routing is performed for signal strings, excluding +5 V and GND. The result is the shortest possible routing within a given column.

Routing Pass 3: (Fig. 4) for each defined edge pin, the nearest signal string (either edge or column) is found and linked into a new string starting at the edge.

Routing Pass 4: (Fig. 5) at this point any given signal will have no more than 12 signal strings, each moving predominantly column-wise. The program now proceeds from one side of the card to the other linking signal strings together. Individual strings may be inverted (turned end-for-end) if this will provide shorter interconnection links.

The result of routing is a near optimum (on the basis of wire length) string of wires connecting pins together. (NOTE that a linked string may be relinked as a single string after future placements.)

COMMANDS

Commands are cards designated by an asterisk "*" in column 1. The next eight characters are the mnemonic command. Successive card fields are numbers (13), I.D. (A8) and comment (5A10). The individual commands are described below.

PROGRAM CONTROL

RESTART reinitialize the program to process another source deck.

END cause the program to exit.

LISTING CONTROL

LIST list cards input.

NOLIST do not list input cards.

MODIFIERS

8-PIN declare mode of successive I.C.'s to be 8-Pin with Pin 4 = GND, 8 = +5 V.

14-PIN declare mode of successive I.C.'s to be 14-Pin with Pin 7 = GND, 14 = +5 V.

16-PIN declare mode of successive I.C.'s to be 16-Pin with Pin 8 = GND, 16 = +5 V.

BUSS declare pin Number to have the default signal assignment of ID. (ID must be "+5 V" or "GND".)

RESERVE declare socket Number to be reserved.

SOCKET declare socket Number to be of type ID. This command is followed by one (if mode is 8-Pin) or two (if mode is 14- or 16-Pin) data cards containing signal names. Comments are maintained with each socket.

EDGE declares that, starting at Edge pin Number, up to ten signals will be defined, from the one card following. Comments are maintained with pin Number.

LINK causes all signals defined to be linked into input strings. (Note: no signal is defined unless that socket is called out.)

CARD print a picture of the card showing all signals on edge pins, and the contents of all sockets.

CLIST print the list of all edge pins used, the signal output, and wires routed to and from that pin, as well as comments assigned to a pin. Then print a list of all non-empty sockets, listing both the socket pin number and the I.C. pin number of each pin, the signal assigned, and all wires routed to and from each pin. Comments input with each socket are listed.

SLIST print a list of all signals, listed in alphabetic order and the list of pins associated with each signal. (List is in routing order).

WLIST — print a wireman's list of all wires used. Each entry will have a check place "()", a wire number, from-location, to-location, and wire length. (Note that wire length is dependent on wire size, so the program lists only insulation length.)

PUNCH — write a file names "PAPER", appropriate to the LBL semi-automatic wire wrap machine, (in the same sequence as printed via WLIST), and print a table of wire wrap machine bin numbers, wire length, and number of wires required.

Both WLIST and PUNCH will first process all +5 V and GND connections, since these are the most common and shortest multiple wire strings. Successive wires will bury these interconnections.

Successive signals will be wired in the order they appear in our table internal to the program. This table may be in either of two forms. The table is originally filled in the order signals are defined. However the command SLIST reorders this table in alphabetical order. Thus, if the SLIST command is given before either WLIST or PUNCH, the wires will be output alphabetically. If SLIST is not called upon, wire settings will be output in the order of definition.

USING THE PROGRAM

The program exists at the computer center as a datacell file, ready to use. The control card sequence required is:

```
-JOB CARD-
LIBCOPY (EEBINARY, AUGAT, AUGAT)
7-8-9 card
AUGAT command desk
6-7-8-9 card
```

The file PAPER is generated if a *PUNCH command is included in the command deck. This file may either be copied or assigned (via a REQUEST card) to the paper tape punch (PP).

INTERNAL DATA STRUCTURE

A brief description of the basic data structure, intended to the program, is included as a reference and guide to others intending to produce a similar program.

There are two basic data structures. The first of these is a NAME structure, in the form of a linear list (vector). Each of the NAME list elements consists of a unique 8-character BCD signal name, and a pointer cell. The pointer cell is used to contain either a negative (Flag) index (for the BUSSED signals, "+5 V" and "GND") or a positive index to an entry in the second data structure, the PIN structure.

The PIN structure element has three major cells; a FLAG cell, a FROM-pointer cell, and a TO-pointer cell. The FLAG cell contains various binary attributes of the pin (such as "Edge Pin", "Signal Source", "Socket Type", etc.).

The PIN-pointer cells are used to link the PIN-elements into a bi-directional signal string, and to link this string to the NAME list element, a pointer value of zero indicates end-of-string list. A positive, non-zero value is an index for the next pin in the list. A negative value can exist only in a FROM-cell, and designates both the beginning of the list, and the negative index of the corresponding NAME cell.

The NAME structure, being a linear list, has an element count associated with it, and indeed, is treated as a stack when new elements are added to it. It may be reordered for alphabetization, at which time appropriate adjustments are made in any pertinent PIN-FROM-pointer cells.

The PIN structure is partitioned into a linear EDGE-PIN array, and a three-dimensioned SOCKET-PIN array. These partitions permit the simple referencing of a pin by position in a socket, and to a socket by its row and column.

Physical (X-Y) coordinates of each pin are derived from these partitions and indices, rather than being carried along with each pin elements.

In addition to the above major structures, there are minor data structures used to map between external representation of device pin labels, external socket pin labels, and internal representations.

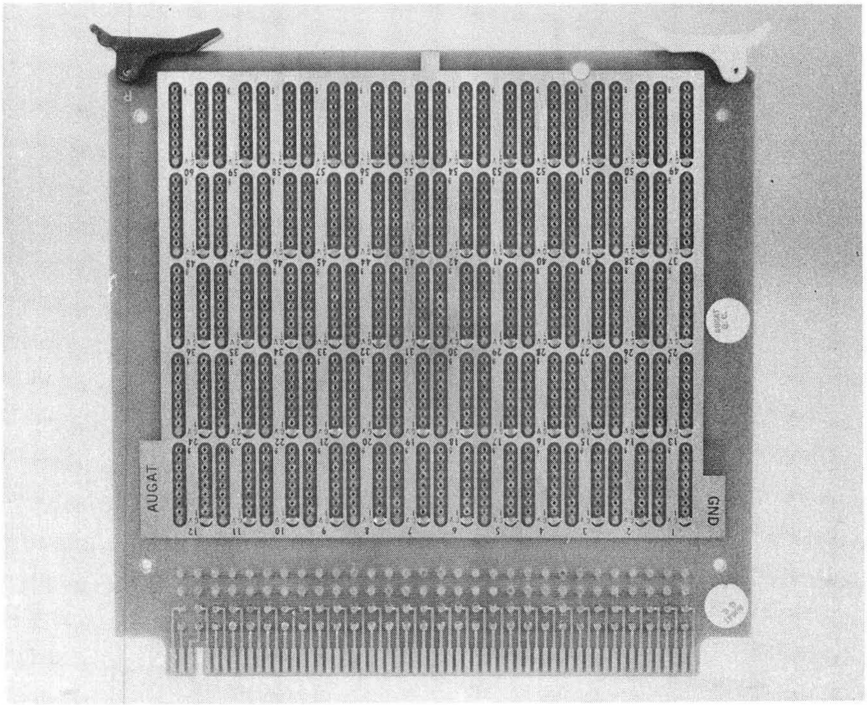

Fig. 1A. Augat Board, Component Side

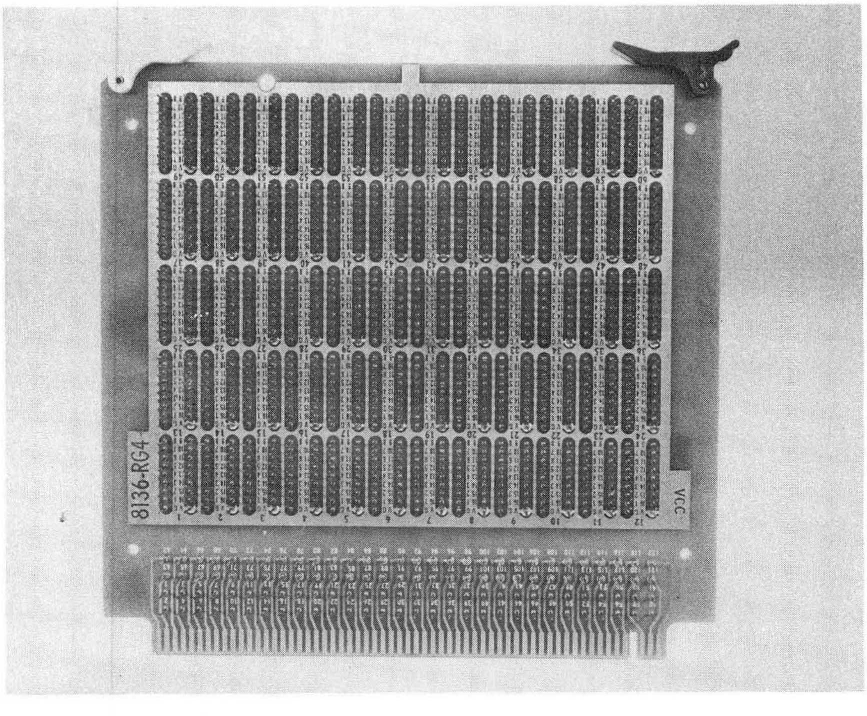

Fig. 1B. Augat Board, Pin Side

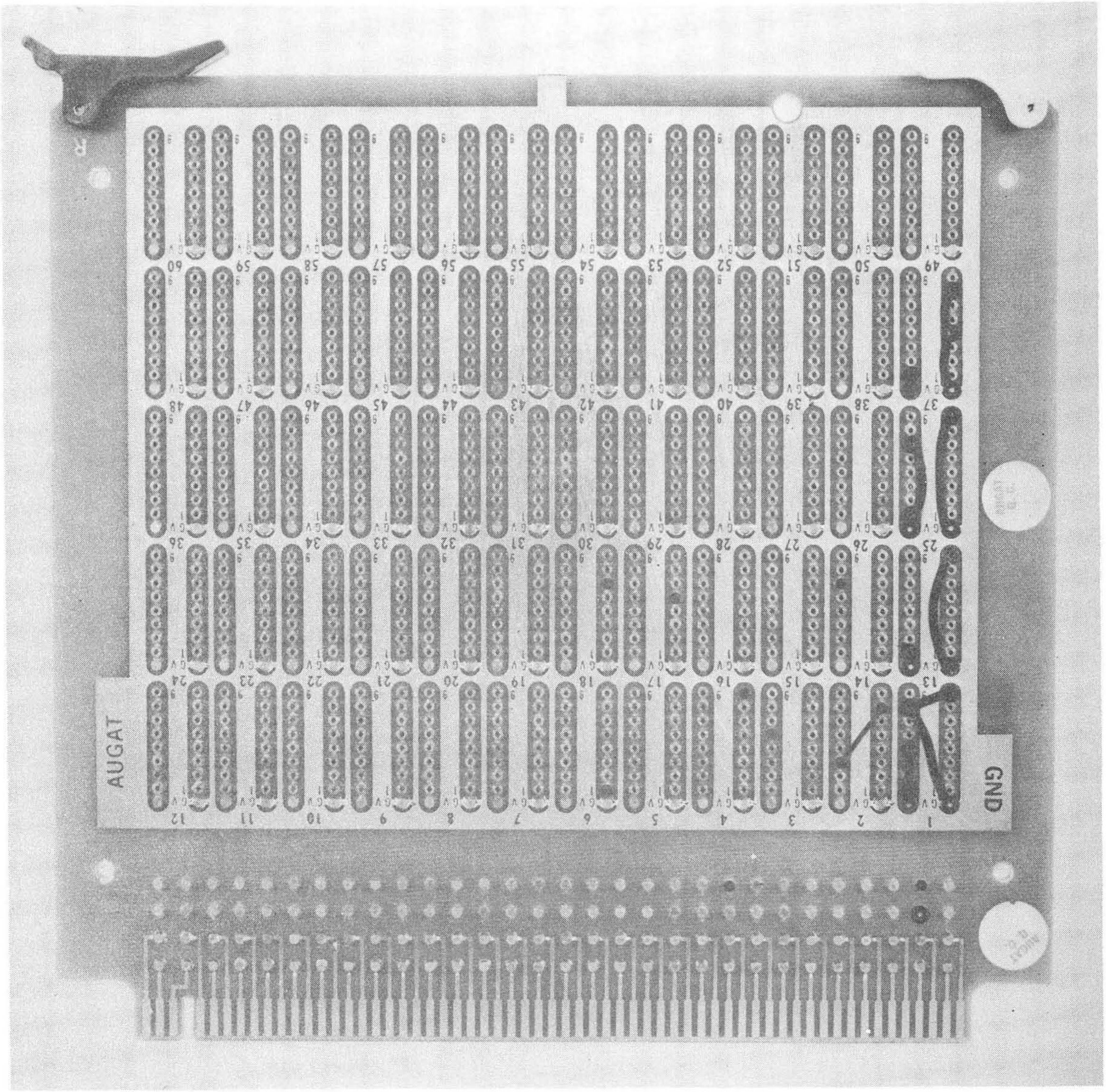

Fig. 2. The interconnection of an arbitrary set of pins after Routing Pass 1. Large circles indicate GND and +5 V; small designate a specific signal. Only interconnections within a socket are generated at this time.

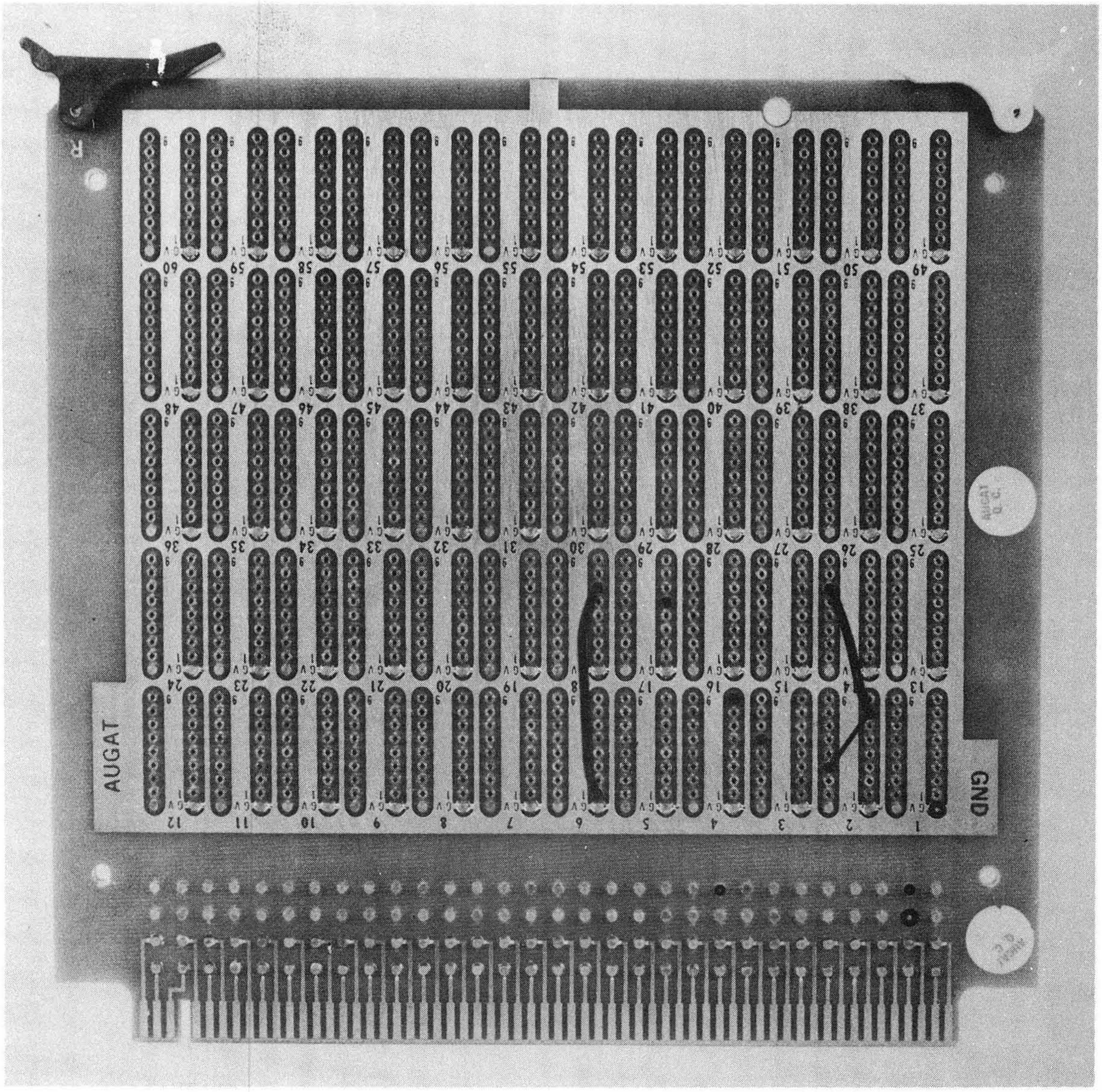

Fig. 3. As in Fig. 2, but now at the completion of Pass 2. Thin Lines indicate previously wired signal strings. GND and +5 V have been eliminated for clarity.

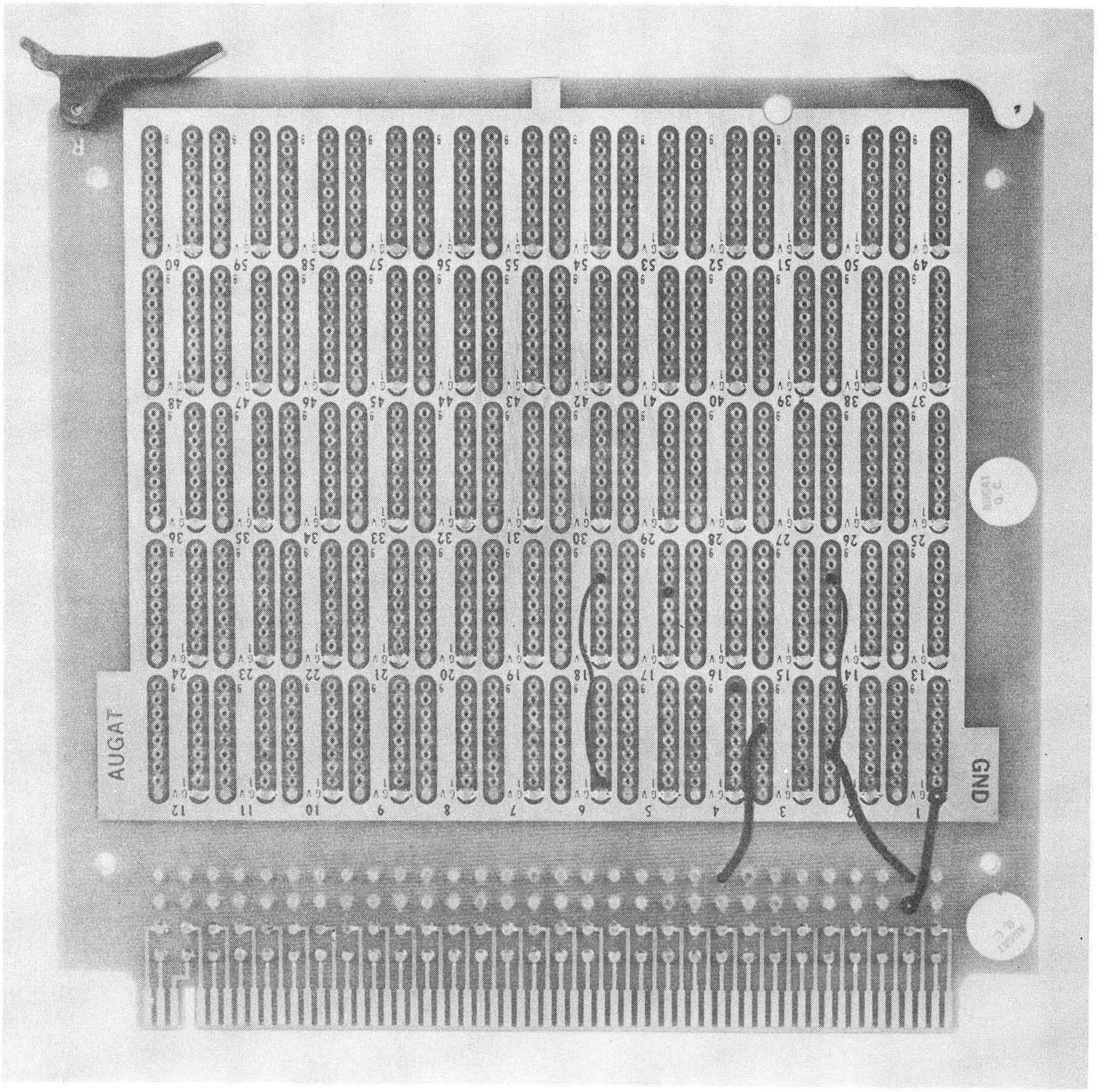

Fig. 4. At the end of Pass 3, edge pins have been connected to nearby columns. Pins interval to previously generated signal strings are not shown.

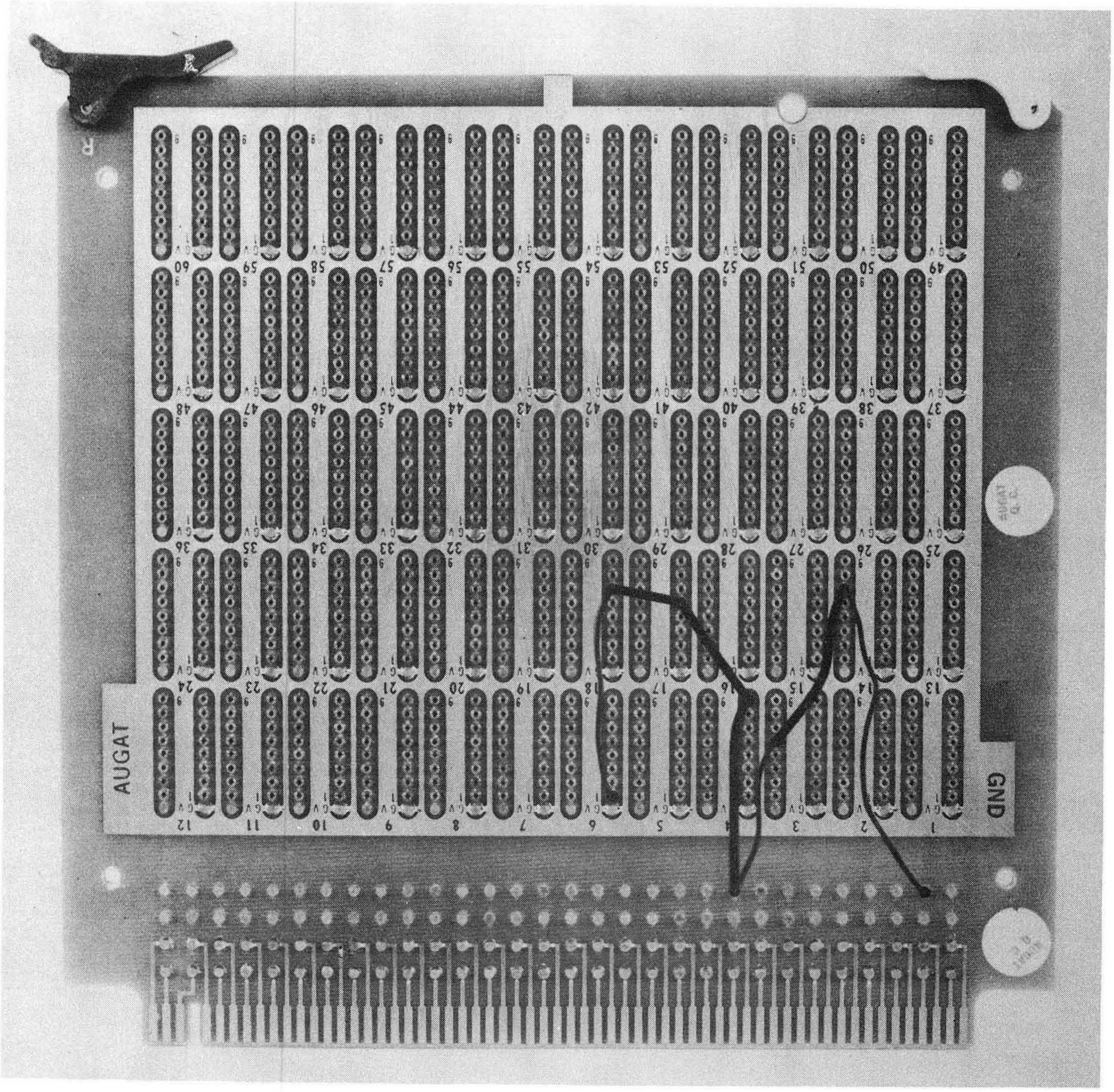

Fig. 5. The board is completely wired.

APPENDIX 1

```
*16PIN
*SOCKET    19301
IN1     IN2
$OUT2   $OUT1
*14PIN
*SOCKET    24601
GND     STROBE                          $*STROBE

*BUSS      5+5V
*BUSS     10GND
*NOLIST
*SOCKET   137491N
                                                                OUT1
*STROBE $CLOCK1 CLOCK1  $ALPHA
*SOCKET   147491N
                                                                OUT2
*STROBE $CLOCK2 CLOCK2  $BETA
*EDGE      1
$+5V    $GND    $IN1    $IN2    OUT1    OUT2            $STROBE *STROBE
*LINK
*CARD
*CLIST
*SLIST
*WLIST
*LENGTH
*PUNCH
*END
```

```
*******************************
*                             *
*    PROGRAM DESCRIPTION      *
*                             *
*******************************
```

AUGAT IS A PROGRAM INTENDED FOR WIRE ROUTING AND DOCUMENTATION INVOLVING AUGAT CARDS OR EQUIVALENT COMPONENTS. THAT IS, EACH CONNECTOR (SOCKET) HAS ASSOCIATED WITH IT 18 INDEPENDENT PINS, IN TWO COLUMNS OF 9 EACH. THESE ARE NUMBERED (V, 1, 2, ..., 7, 8) AND (G, 16, 15, ..., 9, 8). THESE SOCKETS APPEAR IN 5 ROWS OF 12 SOCKETS EACH.

SOCKETS ARE NUMBERED FROM 1-60.

IT IS NECESSARY TO SPECIFY THE LOCATION OF EACH SOCKET WITHIN A CARD, AND THE SIGNALS PRESENT ON EACH PIN. AT THE COMMAND *LINK, A CONNECTION IS DESCRIBED BETWEEN IDENTICAL SIGNALS WITHIN A SOCKET, SUCH THAT THE WIRES RUN FROM ONE END OF THE SOCKET TO THE OTHER, FORMING SIGNAL STRINGS. THEN ALL LIKE SIGNAL STRINGS WITHIN A COLUMN ARE JOINED, MINIMIZING WIRE LENGTHS, AND FINALLY ALL COLUMNS ARE WIRED TOGETHER. THE ALGORITHM USED PROVIDES THAT NO PIN SHALL HAVE MORE THAN TWO WIRES ATTACHED. WHILE THIS SCHEME IS NOT NECESSARILY THE MOST EFFICIENT IN TERMS OF WIRE LENGTH, MAINTAINANCE IS ENHANCED.

FOR CONVENIENCE, DEFAULT CONDITIONS ARE BUILT INTO THE PROGRAM. EACH SOCKET USED HAS 'GND' AND '+5V' DEFINED. THESE MAY BE OVERWRITTEN IF DESIRED, AS DESCRIBED BELOW. INITIAL SOCKET INPUT MODE IS 16-PIN. IF PARAMETER 1 OR PARAMETER 2 ARE UNDEFINED OR 0, THE VALUE 1 WILL BE USED.

CONTROL IS PROVIDED BY CONTROL CARDS, IDENTIFIED BY AN ASTERISK (*) IN COLUMN 1. THESE CONTROLS ARE BY MNEMONIC, WHICH MUST START IN COLUMN 2, CONTAIN NO IMBEDDED BLANKS, AND HAVE TRAILING BLANKS FOR A TOTAL OF 8 CHARACTERS. CONTROLS ARE--

* CONTROL A1 A8	PARAM 1 I3	PARAM 2 A8	DESCRIPTION FORMAT
* END	---	---	TERMINATE PROGRAM
* RESTART	---	---	REINITIALIZE FOR MORE DATA
* NOLIST	---	---	CONTROL CARD PRINTING IS SUPPRESSED
* LIST	---	---	DO NOT SUPRESS LISTING
* EDGE	N	---	READ UP TO 10 SIGNALS FOR EDGEPINS STARTING AT PIN N
* 8PIN	---	---	SIGNAL SEQUENCE IS FOR 8-PIN DUAL-IN-LINE I. C.
* 14PIN	---	---	SIGNAL SEQUENCE IS FOR 14-PIN DUAL-IN-LINE I. C.
* 16PIN	---	---	SIGNAL SEQUENCE IS FOR 16-PIN DUAL-IN-LINE I. C.
* CARD	---	---	PROVIDE A MAP OF POSITIONS ON CARD
* CLIST	---	---	PROVIDE A LIST BY SOCKETS
* SLIST	---	---	PROVIDE A LIST BY SIGNALS
* WLIST	---	---	PROVIDE A WIRE LIST
* PUNCH	---	---	PUNCH A PAPER TAPE FOR AUTO-WIREWRAP
* LENGTH	---	---	PROVIDE WIRE LENGTH LIST

* BUSS	N	SIGNAL	DECLARE SIGNAL TO BE BUSSED AT PIN N (APPLIES ONLY TO *+5V* AND *GND*)
* LINK	---	---	CAUSES ALL SIGNALS AND SIGNAL STRINGS TO BE LINKED TOGETHER
* RESERVE	SOCKET NO	---	DECLARE SOCKET RESERVED
* SOCKET	SOCKET NO	I. D.	SEE BELOW

*SOCKET CONTROL CARDS MUST BE FOLLOWED BY 1 OR 2 CARDS CONTAINING SIGNAL NAMES, IN 10A8 FORMAT. INPUT IS IN PREVAILING MODE (8, 14, OR 16-PIN). ANY CHARACTERS ARE LEGAL IN A SIGNAL NAME, AND ALL PINS WITH IDENTICAL NAMES WILL BE WIRED TOGETHER. ONE SPECIAL CASE IS THAT OF A BLANK NAME. IF BLANK, ANY SIGNAL ALREADY ASSIGNED TO A PIN REMAINS ASSIGNED. (THIS FEATURE PERMITS DEFAULT SPECIFICATION OF GND AND +5V.) A SECOND CASE IS A SIGNAL STARTING WITH THE CHARACTER $. $ INDICATES A SIGNAL SOURCE, AND THUS $SIG IS TREATED AS THE SOURCE OF SIG, AND IS OTHERWISE IDENTICAL TO SIG.

```
16PIN    -0


        SOCKET    19301


                                SOCKET  1
                                 TYPE 9301

        PARAMETERS INPUT

                  SIGNAL  PIN      PIN  SIGNAL
                  IN1      1  0  0 16   +5V
                  IN2      2  0  0 15
                           3  0  0 14
                           4  0  0 13
                           5  0  0 12   $OUT1
                           6  0  0 11   $OUT2
                           7  0  0 10
                  GND      8  0  0 9


                  14PIN    -0


                       SOCKET    24601


                                            SOCKET  2
                                             TYPE 4601

                       PARAMETERS INPUT

                             SIGNAL  PIN      PIN  SIGNAL
                             GND      1  0  0 14   +5V
                             STROBE   2  0  0 13
                                      3  0  0 12
                                      4  0  0 11
                                      5  0  0 10
                             $*STROBE 6  0  0 9
                             GND      7  0  0 8

                   BUSS      5+5V

                       BUSS     10GND

                           NOLIST   -0
```

```
  SIGNAL LIST,  12 SIGNALS

ALPHA      ($) 13-14
BETA       ($) 14-14
CLOCK1         13-13      ($) 13-12
CLOCK2         14-13      ($) 14-12
GND            BUSSED
IN1        ($)   3(EDGE)        1-1
IN2        ($)   4(EDGE)        1-2
OUT1             5(EDGE) ($)   1-12           13-9
OUT2             6(EDGE) ($)   1-11           14-9
STROBE     ($)   8(EDGE)        2-2
+5V            BUSSED
*STROBE          9(EDGE) ($)   2-6            14-11           13-11


NOTE...PIN NUMBERS ARE I.C. PINS, NOT SOCKET PINS


          -FROM-          -TO-      LENGTH            -FROM-          -TO-      LENGTH
 1( )     1-16           1-V           .3    2( )     1-V           1(EDGE)    1.3
 3( )     1-8            1-G          1.0    4( )     1-G           2(EDGE)    1.4
 5( )     2-7            2-1           .8    6( )     2-1          2-G          .3
 7( )    13-12          13-G           .8    8( )     2-16         2-V          .3
 9( )    14-12          14-G           .8   10( )    13-3         13-V          .6
11( )    13-14          13-15          .3   12( )    14-3         14-V          .6
13( )     1-1             3(EDGE)     1.3   14( )    14-14        14-15         .3
15( )     1-12            5(EDGE)     1.6   16( )     1-2           4(EDGE)    1.6
17( )     1-11            6(EDGE)     1.9   18( )    13-11         1-12        1.3
19( )     2-2             8(EDGE)     1.5   20( )    14-11         1-11        1.5
21( )    14-13           2-6          1.1   22( )     2-6           9(EDGE)    1.9
23( )    13-13          14-13          .5

PIN NUMBERS ARE SOCKET PINS, NOT I.C. PINS

       WIRE LENGTH LIST,     23 WIRES TOTAL

       NUMBER  LENGTH

           5      .4
           1      .6
           2      .7
           3      .9
           1     1.0
           1     1.1
           3     1.3
           1     1.4
           1     1.5
           3     1.6
           2     1.9
       BIN NUMBER   WIRE (INSULATION) LENGTH    REQUIRED

           2                 .4                    5
           3                 .6                    1
           4                 .8                    2
           5                1.0                    4
           6                1.2                    1
           7                1.4                    4
           8                1.6                    4
          10                2.2                    2
```

```
CARD MAP

 2D GND      1D +5V       63D          620
 4D IN2      3D IN1       65D          640
                                                 1 9301      13 7491N    25 *EMPTY*   37 *EMPTY*   49 *EMPTY*
 6D OUT2     50 OUT1      67D          660
 8D STROBE   70           69D          680
10D          9D *STROBE   71D          700       2 4601      14 7491N    26 *EMPTY*   38 *EMPTY*   50 *EMPTY*
12D          11D          73D          720
14D          130          75D          740
                                                 3 *EMPTY*   15 *EMPTY*  27 *EM?TY*   39 *EMPTY*   51 *EMPTY*
16D          15D          77D          760
18D          170          79D          780
20D          19D          81D          800       4 *EMPTY*   16 *EMPTY*  28 *EMPTY*   40 *EMPTY*   52 *EMPTY*
22D          210          83D          820
24D          23D          85D          840
                                                 5 *EMPTY*   17 *EMPTY*  29 *EMPTY*   41 *EMPTY*   53 *EMPTY*
26D          250          87D          860
28D          270          89D          880
30D          29D          91D          900       6 *EMPTY*   18 *EMPTY*  30 *EMPTY*   42 *E?PTY*   54 *EMPTY*
32D          310          930          920
34D          330          95D          940
                                                 7 *EMPTY*   19 *EMPTY*  31 *EM?TY*   43 *EMPTY*   55 *EMPTY*
36D          350          97D          960
38D          370          99D          980
40D          390          101D         1000      8 *EMPTY*   20 *EMPTY*  32 *EMPTY*   44 *EMPTY*   56 *EMPTY*
42D          41D          103D         1020
44D          43D          105D         1040
                                                 9 *EMPTY*   21 *EMPTY*  33 *EMPTY*   45 *EMPTY*   57 *EMPTY*
46D          45D          1070         1060
48D          470          109D         1080
50D          490          111D         1100     10 *EMPTY*   22 *EMPTY*  34 *EMPTY*   45 *EMPTY*   58 *EMPTY*
52D          510          1130         1120
54D          530          115D         1140
                                                11 *EMPTY*   23 *EM?TY*  35 *EMPTY*   47 *EMPTY*   59 *EMPTY*
56D          550          117D         1160
59D          57D          120D         1180
60D          61D          121D         1220     12 *EMPTY*   24 *EM?TY*  36 *EMPTY*   48 *EMPTY*   60 *EMPTY*


FDGE PINS USED

     PIN   SIGNAL     -FROM-      -TO-

($)   1    +5V                     1-V
($)   2    GND                     1-G
($)   3    IN1                     1-1
($)   4    IN2                     1-2
      5    DUT1                    1-12
      6    DUT2                    1-11
($)   8    STROBE                  2-2
      9    *ST?OBF                 2-6

NOTF...($) INDICATES SIGNAL SOURCE

PIN NUMRERS ARE SOCKET PINS, NCT I.C. PINS
```

```
SOCKET  1, TYPE 9301
        16-PIN I.C.

    SOCKET                                 I.C.                        SOCKET                                  I.C.
     PIN   SIGNAL     -FROM-    -TO-       PIN                          PIN   SIGNAL    -FROM-     -TO-        PIN
      G    GND        2(EDGE)   1-8                                      V    +5V       1(EDGE)    1-16
      1    IN1        3(EDGE)               1                           16    +5V       1-V                     16
      2    IN2        4(EDGE)               2                           15                                      15
      3                                     3                           14                                      14
      4                                     4                           13                                      13
      5                                     5                     ($)   12    OUT1      5(EDGE)    13-11        12
      6                                     6                     ($)   11    OUT2      6(EDGE)    14-11        11
      7                                     7                           10                                      10
      8    GND        1-G                   8                            9                                       9
```

```
SOCKET  2, TYPE 4501
        14-PIN I.C.

    SOCKET                                 I.C.                        SOCKET                                  I.C.
     PIN   SIGNAL     -FROM-    -TO-       PIN                          PIN   SIGNAL    -FROM-     -TO-        PIN
      G    GND                  2-1                                      V    +5V                  2-16
      1    GND        2-G       2-7         1                           16    +5V       2-V                     14
      2    STROBE     8(EDGE)               2                           15                                      13
      3                                     3                           14                                      12
      4                                     4                           13                                      11
      5                                     5                           12                                      10
($)   6    *STROBE    9(EDGE)   14-13       6                           11                                       9
      7    GND        2-1                   7                           10                                       8
      8                                                                  9
```

SOCKET 13, TYPE 7491N
14-PIN I.C.

SOCKET				I.C.		SOCKET				I.C.
PIN	SIGNAL	-FROM-	-TO-	PIN		PIN	SIGNAL	-FROM-	-TO-	PIN
G	GND		13-12			V	+5V		13-3	
1				1	($)	16	ALPHA			14
2				2		15	CLOCK1		13-14	13
3	+5V	13-V		3	($)	14	CLOCK1	13-15		12
4				4		13	*STROBE	14-13		11
5				5		12	GND	13-G		10
6				6		11	OUT1	1-12		9
7				7		10				8
8						9				

SOCKET 14, TYPE 7491N
14-PIN I.C.

SOCKET				I.C.		SOCKET				I.C.
PIN	SIGNAL	-FROM-	-TO-	PIN		PIN	SIGNAL	-FROM-	-TO-	PIN
G	GND		14-12			V	+5V		14-3	
1				1	($)	16	BETA			14
2				2		15	CLOCK2		14-14	13
3	+5V	14-V		3	($)	14	CLOCK2	14-15		12
4				4		13	*STROBE	2-6	13-13	11
5				5		12	GND	14-G		10
6				6		11	OUT2	1-11		9
7				7		10				8
8						9				

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