

DIGITAL GROUP PRINTER DOCUMENTATION REVISIONS

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46	23 + 0
2	
23	11 + 1
2	
11	5 + 1
2	
5	2 + 1
2	
1	1 + 0

00011101

INTERFACE ELECTRONICS OPERATION

Hardware

The printer interface card essentially converts TTL-level inputs from an output port to appropriate signals that control the print head motor, ribbon advance motor, line feed solenoid operation, and the actual printing of characters by selecting the appropriate impact pins striking the platen.

Status or condition signals from the printer mechanism are likewise converted to TTL levels and received by the driving computer through one input port, as labeled on the schematic.

To print a character, it is necessary to select the number of pins in a vertical column that make up a character. Since the printer uses a 5 x 7 matrix for each character, the interface card must have access to five columns of data at the appropriate times to tell it which pins must strike the paper. Thus in software the computer must provide a look-up table for the complete set of printable characters that are desired. In the source listing provided this table is referred to as a font table. In software the data for each character is stored in five sequential locations, so each byte has the information for one vertical column of a character--seven vertical bits for a character and one bit (the MSB) to provide a strobe.

Since the interface card must interpret both motor commands and actual font data, and must also screen out improper inputs, the interface card uses IC1 (74123) to make sure proper software sequences are followed. IC1, which contains two "one-shot" triggers, is controlled (or strobed) by the MSB input bit. One of the triggers of IC1 latches motor commands into a 74174. The outputs of the 74174 are used to switch on or off the print head motor, forward or reverse, advancing the ribbon, and activating a line feed solenoid. The other trigger of IC1 is used to gate font data into IC's 4 and 5, which turn on the appropriate impact pin solenoid drivers. IC13 is used to synchronize motor commands with the AC line crossing 0 and return a status signal. IC2 (3302, quad comparator package) is used as a protection device for both power on or power down conditions. On initial power-on it clears out motor commands, disables input to the impact pin solenoids with Q3, and also provides a status signal back to the CPU. At other times one of the comparators is used to detect the left printing margin (HOME) and send this status signal back to the computer via the input port. Q3, as previously mentioned, disables input to the impact pin solenoids on initial power-on conditions or power failure conditions of the +35 volt supply.

A summary of status signal to an input port is listed below.

- | LSB.....PRINT FWD
- ⊖ LSB+1.....PAPER OUT (not used)
- | LSB+2.....READY (power on status)
- | LSB+3.....POWER (AC line sync condition)
- \ MSB-3.....PRINT FIELD (not HOME)
- MSB-2.....LINE FEED (status signal)
- MSB-1.....FONT (indicates font-entered condition)
- MSB.....STROBE (MSB condition or status)

To send a motor command to the printer the following sequence must be followed:

- 1. Send the strobe bit (MSB) high with all other bits zero, thus setting up the trigger 10000000
- 2. Send out the appropriate command with the MSB low.
 - a. MOTOR FWD--006 1
 - b. MOTOR REV--005 0000101 5₁₀ 2
 - c. LINE FEED--020 4
 - d. ALL STOP--000 8

16
32
64
128

To send a font to the appropriate solenoid drivers follow this sequence:

- 1. Send out MSB low, i.e., ALL STOP command 000.
- 2. Send out appropriate font with MSB high.

Note: This sequence must be repeated five times for an individual character.

The interface card also generates two on-board voltages: +35 V DC for line feed operation and solenoid drivers for impact pins, and +5 V for the on board TTL operations. Two off-board capacitors hooked into connector 8 filter both voltages.

Software Description

Note: The printer routines supplied on tape with the printer are slightly different from the source listing supplied with the documentation. Both programs are correct versions, and either may be used. Presently we have only documented the Z80 printer routines listing but an 8080 version is available upon request.

The printer routine provides all the software to communicate with the printer, i.e., it does the following:

1. Called as a subroutine, it stores ASCII characters from the calling program in a line buffer beginning at address 010236.
2. Characters as stored in the line buffer are stored sequentially with a maximum of 96 character/line. More or less characters may be included in a line by changing (TXTSZ) from 140 octal to whatever line length is desired. The line buffer extends to the end of page 10. To extend the line length as mentioned above, it is necessary to relocate the line buffer to avoid running into the scroll areas in Maxi-Basic which start in page 11.
3. The printer routines may be relocated or reassembled at any location in memory. It is important, however, that all calls to this routine be changed appropriately.
4. ASCII characters as stored in the line buffer are converted to offset values, referring to the font table which runs from address 007141 to 010235. For example, the letter A 7-bit ASCII code is 101. It is stored as an offset character of 042 meaning that the five sequential font bytes for A are (42)*5 bytes away from the beginning of the font table.
5. A line is terminated by a C/R. Typing "return" on the keyboard begins the printing of one line as stored in the line buffer.
6. Before the characters are printed, the software must set up properly to run the motor forward, start the ribbon, and make sure the printer is starting away from the left margin at a constant speed.

Note: The left printing margin is on the right as you face the printer, and the HOME position (left margin) photo cell detect circuitry should be mounted on the right. In sequence the software must determine the head to be starting at the left margin; if it is not, it must first reverse the head motor until it is HOME. To begin the printing operation, the software starts the motor forward. The motor is left running forward for the entire line to insure equal spacing between characters. When the software detects leaving the left margin it begins printing characters, calling them one at a time from the line buffer and looking up data from the font table. Also, because the driving computer is

much faster than a mechanical printing device, the software inserts timing loops between every vertical row of dots which keep the impact pin solenoids at a duty cycle of about 10%. Hence, the printer head is given time to cool between characters. At the end of a line the printer stops the firing of the impact pin solenoids, returns to the HOME position and activates a line feed solenoid to advance the paper for the next line.

Note: The source listing incorrectly labels step 970 of the printer routine as ribbon advance. This is actually the routine for line feed.

7. Some additional software constants of interest to the user are listed below.

DOUBLE	007131	Filling this location with 200 (bit 7 high) will cause a double hit on each column of a character.
DOTIME	007137 007140	Presently filled with 000147, this constant affects spacing between columns of an individual character and between characters and, as a result, the maximum number of characters per inch printed.
STDLN	007134	The constant stored at this address is presently 076. This affects the intensity of characters printed with the hardware limits set by ICL.

Double 007 127

DOTIME 007 133

STDLN 007 130

Corrections and Changes Made in the Original Documentation

A. List of Corrections and Changes

1. Layout--note Q3 tab is shown correctly on the Parts Layout Sheet included in Section 5.

2. Schematic Errors

Motor control signal (forward and reverse) out of 74174 are shown reversed on the schematic as far as bit significance. Also, motor forward and reverse signals or commands are active high (not low as shown).

3. Figure 1--a corrected drawing is included in Section 5.

S1 should control power for the printer as well as the fan, and should be installed in series with line cord.

Note: When not using the printer, power should be off. This prevents random signals from activating the printer.

4. Figure 2--a corrected drawing is included in Section 5.

Connector 6 wiring--the bold wiring indicates changes and additions to the original Figure 2.

5. Printer Parts List

- a. Add D_1 under 4001 listing: D_1 , D_5 - D_{12} , D_{21} - D_{32} , D_{35} , D_{42} - D_{44}

- ~~b.~~ Add C12 to 1mfd (50V) list: C6-C12

- ~~c.~~ Drop C12 and C14 from .01mfd list: C4, C5, C13, C15-C17

6. Construction Detail--Steps 1-33

- a. Combine steps 4 and 6--4001 diode installation: D_1 , D_5 - D_{12} , D_{21} - D_{32} , D_{35} , D_{42} - D_{44}

- b. Step 12: C4, C5, C13, C15-C17; C14 not supplied.

- c. Step 23--note corrections to layout.

Note: Connectors 1, 4, 5, and 7 are not use on the interface board. Also, the print solenoid connections are made to connector 2 on the interface board, not to the printer mechanism.

B. Additional Construction Detail

- 39) Make I/O connections to computer per instructions 40, 41, 42, and the detail drawings 40A, 41A, and 42A.

- 40) Wire connector 3 (interface card) to a 22-pin printer backplane wirewrap connector (detail 40A).

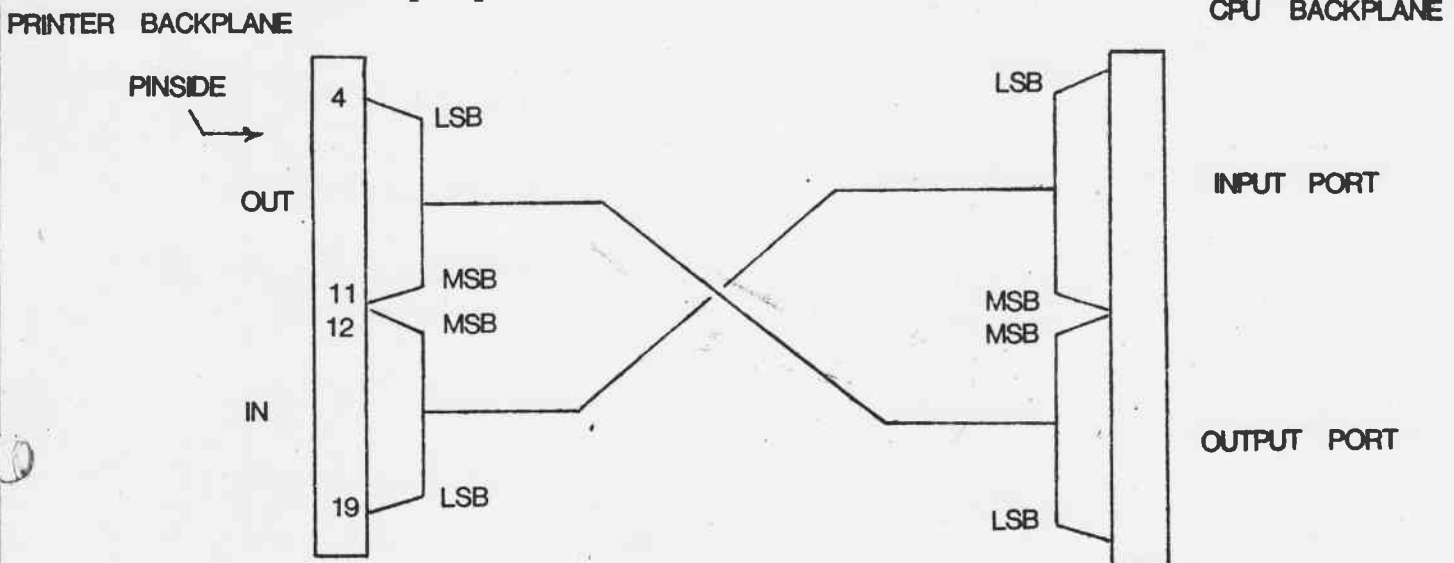
40A) Connector 3 Pin # (interface card)		Backplane Connector Pin #
1 GND	to input port #3	
2 MSB-3	"	15
3 MSB-2	"	14
4 LSB+3	"	16
5 MSB	"	12
6 MSB-1	"	13
7 LSB+2	"	17
8 LSB+1	"	18
9 LSB	"	19
10 MSB-1	from output port #3	10
11 MSB-2	"	9
12 MSB-3	"	8
13 LSB	"	4
14 LSB+2	"	6
15 LSB+1	"	5
16 LSB+3	"	7
17 MSB	"	11

Note: Wiring the printer backplane by this convention (step 42) will maintain the same "bit" significance as adopted for the CPU backplane:

Pins 4-11 LSB to MSB output port
Pins 12-19 MSB to LSB input port

41) Make a cable according to instruction 41A to connect the printer with the computer backplane.

41A) Printer cabinet backplane connections to CPU cabinet via cable and 22-pin paddlecards.

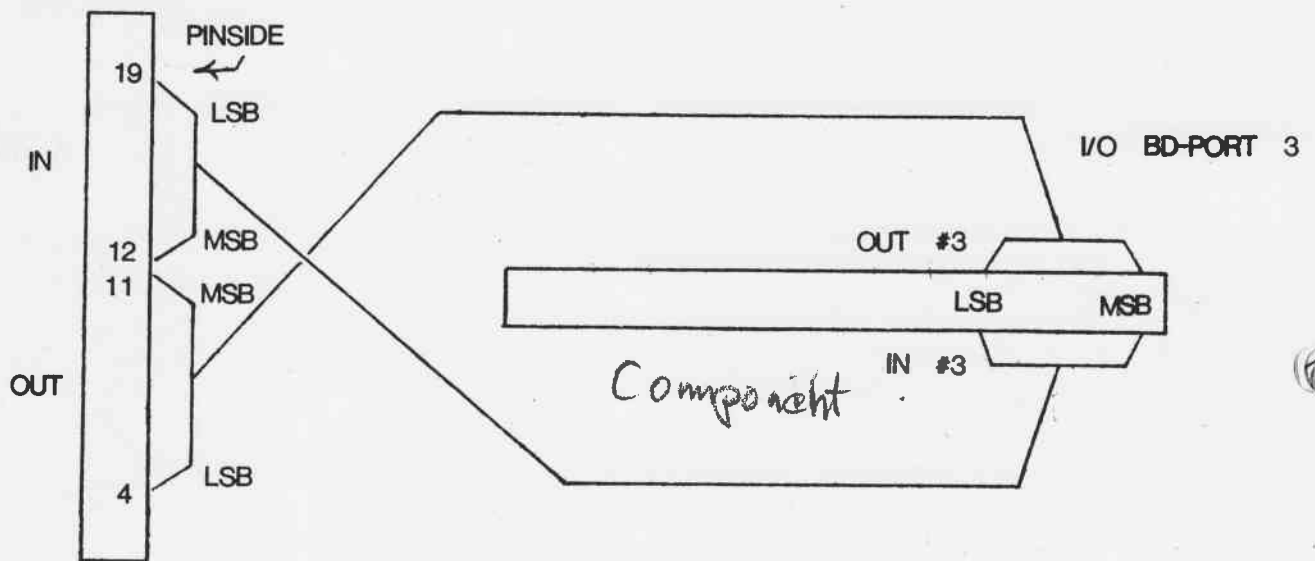


Note: By using this backplane cabling standard, connections to the Digital Group I/O board can be made with two 8-position molex blocks and the cabinet cable is reversible.

42) Wire the connections from the Digital Group CPU backplane to the I/O board (36-pin connector, detail 42A).

42A) CPU backplane connector to Digital Group I/O board (via molex, two 8-position molex blocks).

CPU BACKPLANE



43) Test and operate the printer per operation and debugging procedure (Section IV).

C. Fuse Modification--print solenoid power supply protection circuitry

The following detailed modification can be made and is recommended for current overload protection. It was found that when the solenoid drivers failed, they often shorted leaving the solenoids unprotected by hardware and software duty cycle protection.

Mechanical and Physical Inspection Items

A. Normal Printer Operation

The Digital Group Printer is designed to print from right to left as you face the printer. This is required since the software only stores one line at a time rather than one page of copy which would be necessary for printing from left to right. However, the user can make this an option by rearranging the necessary fonts and by providing a larger buffer area.

The Practical Automation Instruction Manual included with the documentation can provide useful information for modification, electrical hook-up, and maintenance. It should be noted that the photocell circuitry (HOME POSITION DETECT) had been modified so that printing begins at the far right.

Pages 3-4 provide electrical and mechanical data on the printer mechanism itself.

Page 5 provides information on paper supplies, inking rollers, and the line feed (advance) ratchets. Practically any type of paper may be used: roll, cut or fanfold paper, as long as the width does not exceed 8-1/2 inches.

Page 8 is a chart showing printing speed characteristics.

Page 10 shows the typical print solenoid driver circuitry similar to that employed in the Digital Group interface card design.

Page 13 shows the user ribbon installation instruction.

Page 17 (drawing B11-80128) shows the electrical circuitry of the printer mechanism itself with a typical printer interface card.

To load paper into the Digital Group Printer follow the instructions on page 14 or Figure 8. Paper may be advanced manually past the advance roller by reaching under the printer to advance the roller.

If the print density is not consistent vertically, it is possible to adjust the platen or flat bar over which the paper feeds. This is done by two set screw adjustments directly below the platen.

Section 5 contains a component layout showing modifications to add a fuse in the print head supply line. The fuse is being installed between diode D₄₁ and connector 2. Two traces must be cut (see the revised layout), one to put the fuse in the 35V supply line and the other to connect the second fuse lead to the board without additional drilled holes. Two fuse clips are supplied. Snap the clips on each end of the fuse and center the fingers in the holes. (Clip one finger off each fuse clip.) Solder in the clips and attach the wires as indicated on the layout. The recommended fuse is a 1/2 amp slow-blow fuse. Do not exceed a 6/10 amp slow-blow fuse.

Parts Included

- 2 1/2 amp slow-blow fuses
- 2 fuse clips

Operation and Debugging Procedures

The following procedure should allow you to debug your printer in the shortest time and to avoid catastrophic failures. Use a DC voltmeter and scope if available.

Assemble the board. Do not hook the printer to the interface card. Hook the interface card to the input and output port 3. Using Maxi-Basic (option 7), enter the following program.

```

10 FOR I = 1 TO 200
20 OUT 3, 0
30 OUT 3, 255
40 NEXT
50 FOR I = 1 TO 200
60 OUT 3, 0
70 OUT 3, 128
80 NEXT
90 GOTO 10

```

Voltmer: Run this program. Place a 1K resistor from pin 8 connector 2 to pins 9, 10, 11, 12, 13, 14 and 15 successively, and, using a portable voltmeter, measure the voltage across the resistor. The voltage should slowly pulse from 0 volts to 5-7 volts. (+ side of the voltmeter is hooked to pin 8). A constant +35 volt reading indicates a shorted TIPL20 associated with that pin or a 7409 that has a constantly high output. A zero voltage reading indicates an open TIPL20 or a 7409 with low output.

Scope: If a scope is available, make sure the pulses are travelling from connector 3 through the 7409 to the TIPL20's. Check that IC1 outputs are pulsing correctly.

If everything checks your print drivers are probably operating correctly.

Now change lines 20, 30, 60 and 70 of the Maxi-Basic program.

```

20 OUT 3, 128
30 OUT 3, 127
60 OUT 3, 128
70 OUT 3, 0

```

Voltmeter: Voltage (measured with reference to ground) at pins 2, 6, 4 and 8 of IC7 and at pin 6 of IC5 should be slowly pulsing between 0 volts and +5 volts. Failure of one of these outputs to do so indicates a localized problem at that point. If they all fail to pulse

IC7

2 = V+1.2 Steady
4 = V+1.1
6 = V+1.1
8 = V Steady

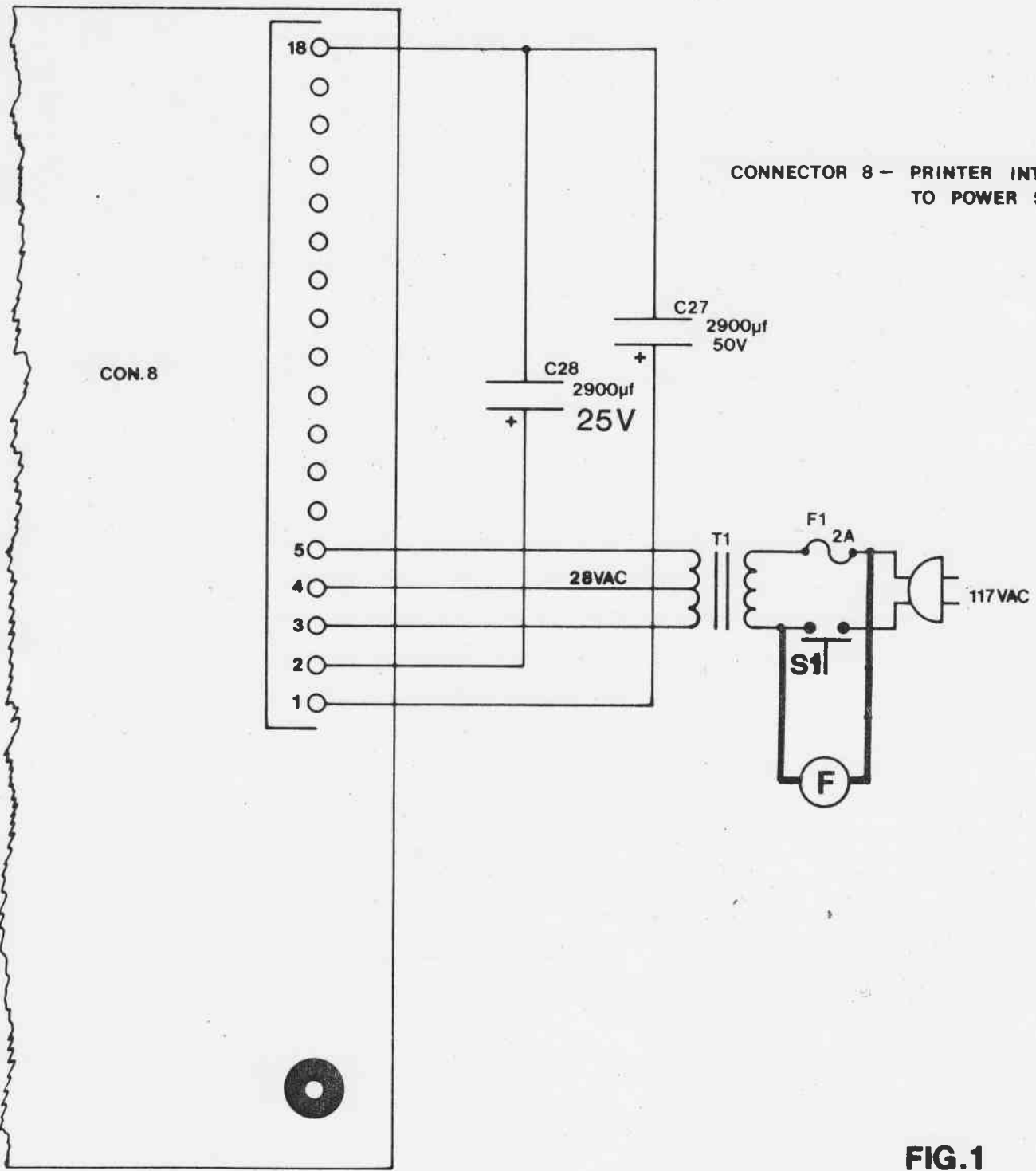
6 = 0 Steady

the problem is associated with IC6.

Scope: Pin 9 might not be clocking correctly or pin 1 might be going low and clearing IC6. A problem at pin 9 indicates IC1 might be at fault. A problem at pin 1 indicates IC2 (3302) and the power-up circuitry might be at fault. After power-up, pin 14 IC2 should be between +3 and +5 volts.

If everything checks, connect the printer to the interface. The fuse modification should have been made by this time.

Use portion 9 on Maxi-Basic and type return several times. The printer should respond by printing "SYNTAX ERROR". If a fuse blows, replace it with a .6 amp slow-blow fuse. Never use a larger fuse or jumper. If the head fails to move you might try sliding it to the left. Problems beyond this point should be directed to the Digital Group.



CONNECTOR 8 - PRINTER INTERFACE CARD
TO POWER SUPPLY.

FIG.1

CONNECTOR 6 HOOKUP CORRECTIONS

CONNECTOR 6 - PRINTER INTERFACE CARD TO
PRINTER MECHANISM CONNECTOR.

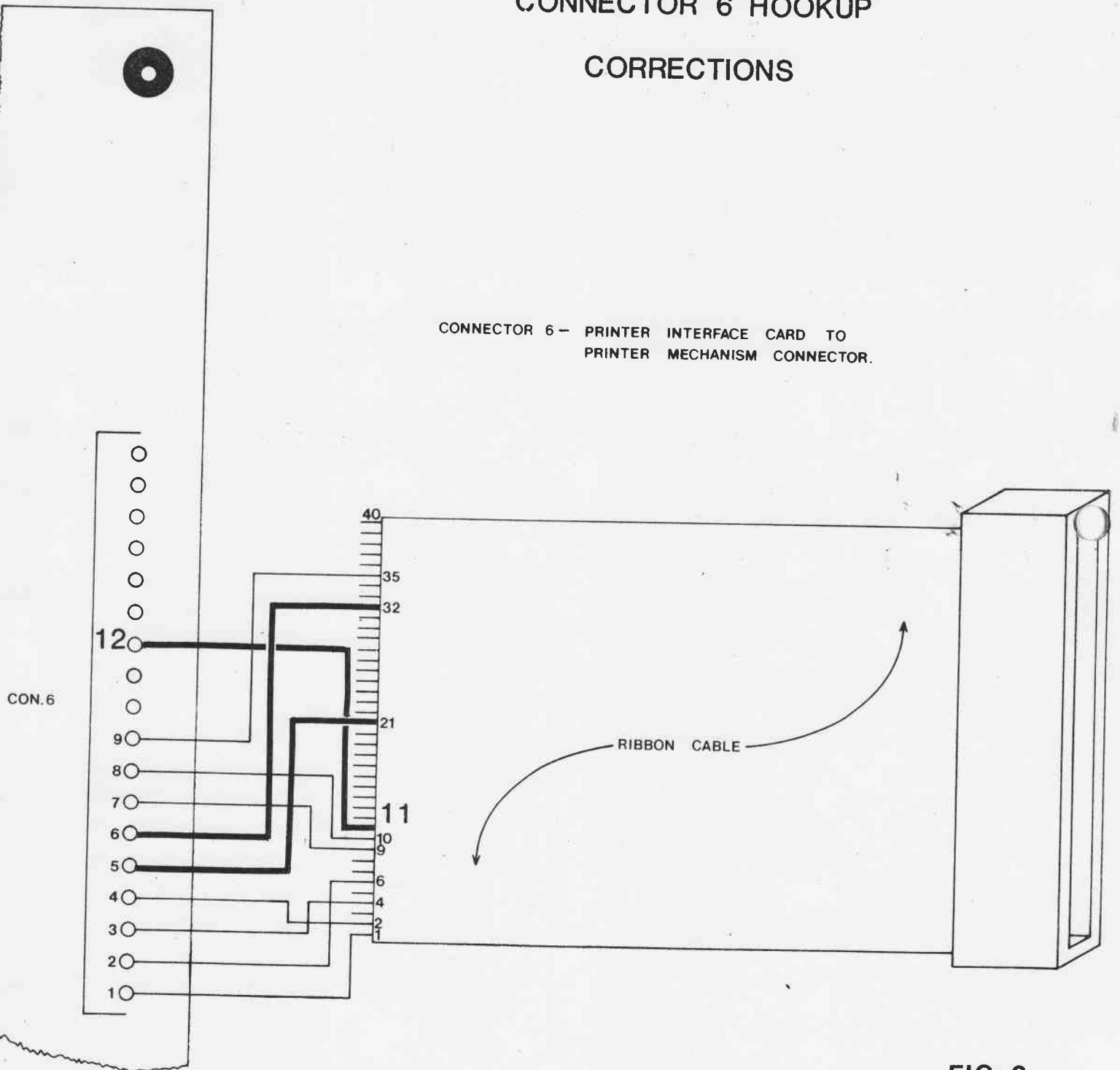


FIG. 2