PROGRAMMING AND SERVICE MANUAL

MODEL 59405A

HP-IB CALCULATOR INTERFACE

(THIS MANUAL ALSO COVERS MODEL 11144A ASCII BUS INTERFACE)

Serial Number 1444A00101 and higher

NOTICE

Any manufacturing changes in the instruement will appear in a "Manual Changes" supplement to this manual. You may want to transcribe these changes into the manual.

If the Serial Number of your instrument is lower than the one on this title page, the manual contains revisions that do not apply to your instrument. Backdating information given in the manual adapts it to earlier instruments.

Where practical, backdating information is integrated into the text, parts list and schematic diagrams. Backdating changes are denoted by a delta sign. An open delta (Δ) or lettered delta (Δ_A) on a given page, refers to the corresponding backdating note on that page.

WARNING

To help minimize the possibility of electrical fire or shock hazards, do not expose this instrument to rain or excess moisture.

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CERTIFICATION

Hewlett-Packard Company certifies that this system met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards, to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

The Hewlett-Packard Model 59405A HP–IB Calculator Interface System is warranted against defects in material and workmanship for a period of 90 days from date of shipment. Hewlett-Packard will, at its option, repair or replace without charge, any parts which prove to be defective during the warranty period. Warranty service will be performed on-site at the customer's facility where the customer's facility is within 2 hours or 100 miles from a Hewlett-Packard Service Facility and such customer facility is accessible and served by daily commercial surface transportation. Customers with facilities outside this area shall be charged for travel costs in accordance with Hewlett-Packard's then current rates. Hewlett-Packard reserves the right to remove instruments from the system that cannot be repaired on-site at the customer's facility, for a priority bench repair at a Hewlett-Packard service facility. The on-site 90 day systems' warranty is in lieu of the one year return–to–Hewlett-Packard warranty described in the individual instrument manuals. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

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SECTION I
GENERAL INFORMATION

1-1. HEWLETT-PACKARD INTERFACE BUS DESCRIPTION.

1-2. The Hewlett-Packard Interface Bus is a serial-byte bus structure which permits bi-directional communication between multiple instruments. When a controller such as a calculator is used, this control can be accomplished with only one I/O slot for up to 14 additional devices.

1-3. Instruments can be controlled or programmed and data can be transmitted between devices on the bus. This is possible since each device connected to the bus has the potential of being a talker or a listener and has a unique talk and/or listen address by which a controller interrogates or communicates with the instruments.

1-4. A unique three wire handshake technique allows the communication to take place at a speed determined only by the specific instruments being addressed. Slower devices will not slow down the communication speed of the bus as long as they are not addressed.

1-5. The interface system consists of a set of sixteen lines which are used to carry all data and control information between the interconnected devices. The bus structure is organized into three sets of signal lines:

data bus, 8 signal lines

data byte transfer control or handshake, 3 signal lines

general interface management, 5 signal lines.

1-6. The data bus carries 8 bit data and control messages in bit parallel, byte serial form. The messages are transmitted bi-directionally and asynchronously.

1-7. The three data byte transfer control or handshake lines are used to transfer each byte of data from an addressed talker to all addressed listeners. The lines are

Data Valid (DAV) – used to indicate valid information is available on the data lines.

Not Ready for Data (NRFD) – used to indicate the readiness of devices to accept information.

Not Data Accepted (NDAC) – used to indicate the condition of acceptance of the information by the listeners.

1-8. Finally, five interface lines are used to manage an orderly flow of information across the interface.

Attention (ATN) – used to specify the nature of the information on the signal lines such as address or instruction information.

Interface Clear (IFC) – used to place the system in a known quiescent state.

Service Request (SRQ) – used to indicate the need of a device for attention.

Remote Enable (REN) – used to enable instruments to go into remote control.

End or Identify (EOI)* – used to indicate the end of a multiple byte transfer sequence or in conjunction with ATN to execute a parallel status polling sequence.

1-9. The bus structure thus provides for data transfer, control, status checking, status interrogation, remote/local control, group triggering and other control features making it a uniquely flexible structure. Consult individual instrument specifications to verify their specific response to these functions.

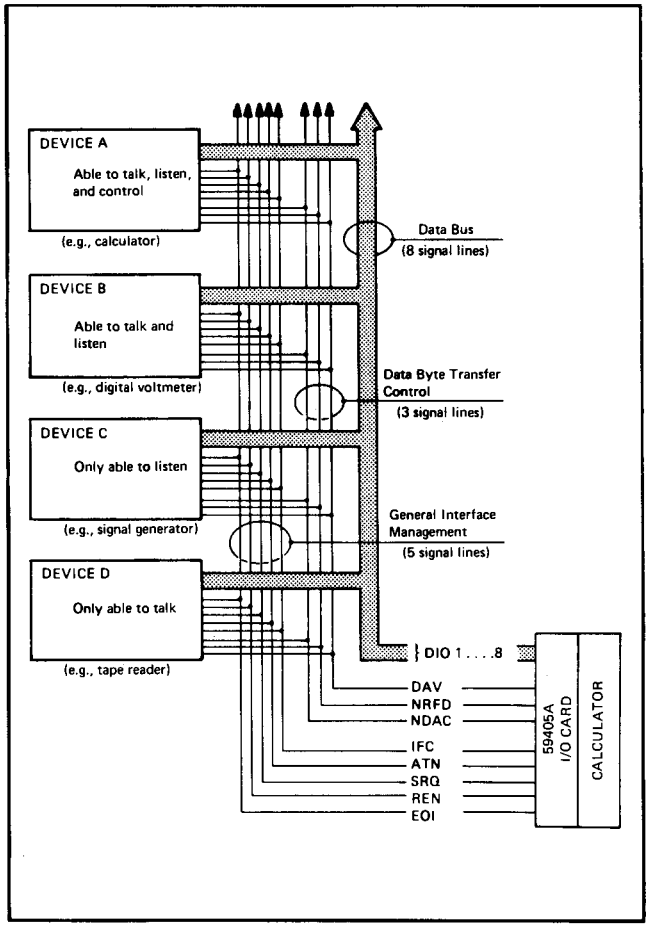


Figure 1-1. Interface Capabilities and Bus Structure.

*The 59405A does not operate EOI.

1-10. 59405A DESCRIPTION.

1-11. The 59405A connects the 9820A, 9821A and 9830A calculators to the Hewlett-Packard Interface Bus. The 59405A provides both control and data capability for up to 14 additional HP-IB controlled devices using a single I/O slot. The HP-IB allows you to interconnect and add new instruments simply by adding a cable. No additional interface cards, special cables or logic converters are necessary. In addition, the software control is vastly simplified since all instruments can be controlled using the same general software format. Addition of a new device does not require major software revisions and makes expansion of a system a simple matter.

1-12. The 59405A can be used with a wide variety of instruments and accessories that are available which are interfaced to the Hewlett-Packard Interface Bus. It simplifies user assembly of special purpose systems which are tailored specifically to the users' needs. Systems are easily configured to solve problems in production test, environmental measurements, or process control. Systems doing stimulus, stimulus/response, or response testing are possible due to the control and data capabilities of the HP-IB.

1-13. The 59405A contains all the necessary hardware and software to operate instruments and help diagnose problems in the I/O card. Included are the I/O card, appropriate ROM for I/O control and 12 foot cable. Also included is a Users Guide describing how the calculator can be used to communicate with and control instruments and accessories.

1-14. SPECIFICATIONS.

1-15. Table 1-1 is a complete list of the Model 59405A critical specifications that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the Model 59405A.

1-16. Any change in the specifications due to manufacturing, design, or traceability to the U.S. National Bureau of Standards will be listed on a manual change sheet included with this manual. The manual and manual change sheet supersede all previous information concerning specifications of the 59405A.

1-17. OPTIONS.

Option 020 – 9820A operation
Option 021 – 9821A operation
Option 030 – 9830A operation

Table 1-1. Specifications.

Logic levels: all lines ground true, 1 = true $\leq$ .8 V, 0 = false $\geq$ 2.0 V.
Input loading: (1 Interface Bus load). Each of the 16 bus lines is terminated with 3 kΩ to +5 V, and 6.2 kΩ to ground. Each input is equivalent to one TTL load (or less).
Output circuits: (fan out = 14 Interface Bus loads). Each output can drive 14 Bus loads. The output is an open-collector driver, capable of sinking 50 mA to 0.4 volts out.
Temperature: 0° to 55°C (32° to 131° F) operating.

Table 1-2. General Information.

Function: Interfaces the 9820A, 9821A, and 9830A calculators to the Hewlett-Packard Interface Bus. Provides both input and output capability.
Interfacing to calculator: -hp-'s 59405A plugs directly into any I/O slot in the calculator. A suitable ROM, provided with the 59405A, must be plugged into the calculator to complete the interface. -hp-'s 59405A has a fixed calculator select code of 13.
Operating modes

1. Listen mode: calculator can input data from the bus when addressed.
2. Talk mode: calculator can output data to the bus when addressed. (The calculator must address itself.)
3. Controller mode: calculator can control the HP-IB by transmitting addresses and commands to the bus.
4. System controller mode: the 59405A is normally configured to make it the system controller. System controller is the highest level of bus control, being capable of initializing the bus at any time with IFC and REN.
5. Service request monitor mode: the calculator can monitor the Service Request line (SRQ), making it possible for an HP-IB instrument to request service.

NOTE

The 59405A cannot control the End or Identify (EOI) line and as such, it cannot be used to do a parallel status poll. When used with controllers, the 59405A cannot receive the universal commands defined for the HP-IB such as Local Lockout or Group Execute Trigger. It can, however, transmit those commands to other devices on the bus.

Hewlett-Packard Interface Bus Addressing: -hp-'s 59405A has talk address "U" and listen address "5". However, any of 31 pairs of talk/listen address combinations can be selected by means of internal jumpers.
Connector: the standard HP-IB connector is mounted on the 59405A.

1-18. ACCESSORIES SUPPLIED.

I/O Card
Peripheral Control II ROM (9820A/21A only)
Extended I/O ROM (9830A only)
Cable 10631C
Programming and Service Manual
Users Guide
Verification software
HP-IB Test Card

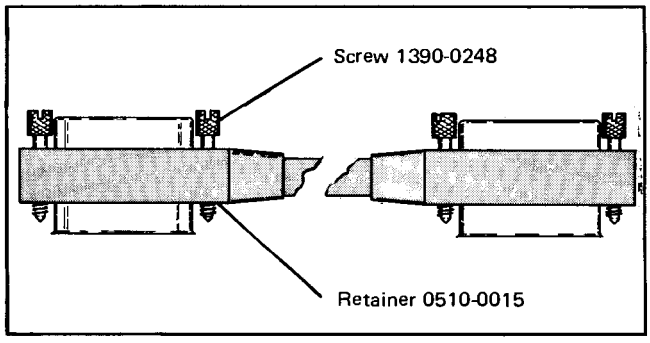


Figure 1-2. 10631A/B/C Cable.

1-19. ACCESSORIES AVAILABLE.

3495A Scanner –
Scan or provide contact closure control for up to 40 channels.

59301A ASCII-to-Parallel Converter –
Output ASCII codes transmitted on the HP-IB. Up to 16 digits of BCD information to run printers or program instruments.

59303A Digital-to-Analog Converter –
Convert 3 digits of information to analog signal of up to ± 10 volts.

59304A Numeric Display –
Display and store 12 digits of numeric information in scientific notation from any device connected to the HP-IB.

59306A Relay Actuator –
Control six form C relay contacts.

59307A VHF Switch –
Switch VHF signals to 500 MHz. Two independent single-pole, four-throw switches available.

59308A Timing Generator –
Generate timing signals at precisely known and programmable intervals.

59309A ASCII Digital Clock –
Read or display time of day, day, month, year.

59400A TTY/RS232 Interface –
Interface to any RS232 code device such as a Teletype or CRT display.

59401A Bus System Analyzer –
Troubleshoot hardware or software problems on the HP-IB.

59403A Common Carrier Interface –
Communicate over 3000 feet of dual twisted pair or over the telephone system using the optional modem.

10631A Cable – 3 foot HP-IB Cable

10631B Cable – 6 foot HP-IB Cable

10631C Cable – 12 foot HP-IB Cable.

1-20. INSTRUMENT AND MANUAL IDENTIFICATION.

1-21. This manual applies to instruments with the serial numbers shown on the title page. If changes have been made in the instrument since this manual was printed, a "Manual Changes" supplement supplied with the manual will define these changes. Be sure to record these changes in your manual. Part numbers for the manual and the microfiche copy of the manual are also shown on the title page.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information on initial inspection, power and grounding requirements, installation and interfacing information, and shipping instructions.

2-3. INITIAL INSPECTION.

2-4. The 59405A was both mechanically and electrically inspected before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. To confirm this the 59405A should be inspected for physical damage which may have occurred in transit and the electrical performance checked with the verification software supplied with the 59405A. If there is damage or deficiency, see the warranty inside the front cover of this manual.

2-5. POWER AND GROUNDING.

2-6. The 59405A receives its power and grounding connections from the 9820A, 9821A or 9830A Calculator.

2-7. INSTALLATION.

2-8. To install the 59405A Interface Card in the calculator, proceed as follows:

a. Turn the calculator off.

b. Insert the I/O card into any one of the four I/O slots on the rear panel of the calculator. Press the card firmly into the slot.

c. Plug in the Peripheral Control II ROM (9820A/21) or Extended I/O ROM (9830A). The Peripheral Control II ROM must be installed in the slot that is stated in the documentation of any pre-recorded software; the Extended I/O ROM may be installed in any slot.

2-9. INTERFACING.

2-10. The 59405A 24 pin series 57 microribbon connector interfaces directly to the Hewlett-Packard Interface Bus. There are three HP-IB cables available. All cables are identical except for length. The -hp- model number and length for each cable is as follows:

-hp- Model No.	Cable Length
10631A	3 ft.
10631B	6 ft.
10631C	12 ft.

2-11. As many as 14 devices may be connected to the 59405A with any cable configuration deemed suitable to the user but with a maximum accumulative cable length of

- 2 meters times the number of devices (59405A is one device),
- or 20 meters, whichever is less.

2-12. REPACKAGING FOR SHIPMENT.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.

2-13. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropriate packing material and seal well with strong tape or metal bands. If the original container is not available, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips or plastic foam.

c. Place instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

SECTION III
PROGRAMMING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains some basic reference information and a few programming examples on the use of a Hewlett-Packard calculator as a System Controller on the Hewlett-Packard Interface Bus (HP-IB). See the HP-IB Users Guide for further information. It will be assumed that the user is proficient with the calculator language including the variations explained in the optional ROM manuals.

3-3. HP-IB MODES.

3-4. The bus has two modes of operation that are accessed by the active controller and defined by the level of the bus ATN line:

1. Command mode (ATN low)
2. Data mode (ATN high)

3-5. The calculator/59405A* as bus controller may access the Command mode and "address" the devices that are to "talk" or "listen" in the Data mode. It may then access the Data mode so that the addressed devices, including the calculator itself, may send or receive operating instructions or measurement data. Only one device at a time may talk but any number may listen simultaneously.

3-6. So the calculator may act as controller, talker, or listener to access the two bus modes, address instruments or itself in the Command mode, and send instrument instructions, receive measurement data or simply wait for other devices to communicate in the Data mode.

3-7. Accessing Bus Modes.

3-8. Table 3-1/3-2 gives the methods to access the two bus modes. The first and succeeding alternate quote fields in a CMD statement send talk or listen address characters in the Command mode; the second and succeeding alternate quote fields send instruction or data characters in the Data mode (provided that the calculator and an instrument have been addressed to talk and listen respectively). The CMD statement always leaves the bus in the Data mode regardless of which mode it last sends characters in.

3-9. I/O OPERATIONS AVAILABLE.

3-10. Once the desired bus mode has been accessed the desired addresses, instrument instructions or measurement data may be sent or received by the operations listed in Table 3-3/3-4. Usually the output operations can be combined with the statements of Table 3-1/3-2 to conserve calculator memory.

Table 3-1. Accessing Bus Modes with 9820A/21A.

BOTH MODES	0: CMD"*command mode characters*", "*data mode characters*", "*command mode characters*", *etc.*
COMMAND MODE	0: FMT Y1,Z;WRT 13
DATA MODE	0: FMT Y2,Z;WRT 13 *or* 0: CMD""

NOTE: "13" is the 59405A peripheral select code.

Table 3-2. Accessing Bus Modes with 9830A.

BOTH MODES	10 CMD "*command mode characters*", "*data mode characters*", "*command mode characters*", *etc.*
COMMAND MODE	10 FORMAT B 20 OUTPUT (13,10)256;
DATA MODE	10 FORMAT B 20 OUTPUT (13,10)512; *or* 20 CMD""

NOTE: "13" is 59405A peripheral select code.

3-11. The calculator must have been properly addressed in the Command mode before it can output or input in the Data mode, but it can unconditionally access either mode according to Table 3-1/3-2 and unconditionally output in the Command mode with the operations of Table 3-3/3-4. An exception to this rule is that the status input may be checked independent of addressing; see Paragraph 3-23.

3-12. CALCULATOR TALK/LISTEN.

3-13. The calculator may be addressed only to talk or to listen, not to do both simultaneously. To address the calculator to talk after it has been addressed to listen, the characters "?U" must be used; to address the calculator to listen after it has been addressed to talk, "Z5" must be used. Where

? = universal Unlisten command.
U = calculator talk address.
Z = a talk address other than calculator's.
5 = calculator listen address.

* Assume that the 59405A is included wherever the calculator is mentioned in Section III of this manual.

Table 3-3. 9820A/21A I/O Operations Available.

OUTPUT	CMD	Sends one or more literal alphanumeric characters.
	FMT WRT 13	Sends one or more literal alphanumeric characters or variable numeric characters.
	WTB 13	Sends one variable alphanumeric character.
INPUT	FMT RED 13	Receives one or more numeric characters.
	RDB 13	Receives one alphanumeric character.
	RDS 13	Receives status input of 59405A.

NOTE: character = one ASCII code.
literal = within quotation marks.
variable = derived from computation or keyboard input.
numeric = polarity signs, digits, decimal point, "E".
alphanumeric = any ASCII character.

Table 3-4. 9830A I/O Operations Available.

OUTPUT	CMD	Sends one or more literal alphanumeric characters.
	FORMAT OUTPUT (13,_)	Sends one or more literal alphanumeric, variable alphanumeric or variable numeric characters.
INPUT	FORMAT ENTER (13,_)	Receives one or more alphanumeric or numeric characters.
	RBYTE 13	Receives one alphanumeric character.
	STAT 13	Receives status input of 59405A.

See Note of Table 3-3.

3-14. STATUS OUTPUT.

3-15. Two lines on the bus and a flag in the 59405A may be set true (low) or false (high) by program statements and other means described in the following paragraphs:

3-16. ATN Line.

3-17. The ATN line determines the bus mode of operation; see Paragraph 3-3. Four operations control ATN:

1. Software may set ATN low or high; see Table 3-5/3-6. Control flag (Paragraph 3-21) must be true before software can set ATN low.

2. Calculator STOP key sets ATN low (since the calculator is System Controller).

3. Interface Clear signal from another System Controller sets ATN high.

4. Calculator power-on sets ATN low.

3-18. REN Line.

3-19. The REN line selects the remote or local mode of operation of instruments; this is necessary only for instruments that have both local and remote modes of operation such as the 3490A Multimeter. The 3495A Scanner for instance is only remotely controllable and does not respond to the REN line. Only a System Controller is permitted to pull the REN line low (true). Two operations control REN:

1. Software may set REN true or false; see Table 3-5/3-6.

2. Calculator power-on sets REN true.

3-20. Generally, an instrument must also receive its listen address in addition to sensing that REN is low before it goes to the remote mode.

3-21. Control Flag.

3-22. The Control flag enables the calculator to act as bus controller by allowing it to pull the ATN line low to give the bus Command mode; the calculator may then send addresses on the bus. Four operations work the Control flag:

1. Software may set Control flag true or false; see Table 3-5/3-6.

2. Calculator STOP key sets Control flag true (since the calculator is System Controller).

3. Interface Clear signal from another System Controller sets Control flag false.

4. Calculator power-on sets Control flag true.

Table 3-5. 9820A/21A Status Output Statements.

Statements	Result
0: FMT Y1,Z; WRT 13	ATN line low (Command mode)
0: FMT Y2,Z; WRT 13	ATN line high (Data mode)
0: FMT Y3,Z; WRT 13	REN line low (Remote mode)
0: FMT Y4,Z; WRT 13	REN line high (Local mode)
0: FMT Y5,Z; WRT 13	Control flag true (Controller mode)
0: FMT Y6,Z; WRT 13	Control flag false (Non-controller mode)

Table 3-6. 9830A Status Output Statements.

Statements	Result
10 FORMAT B	
20 OUTPUT (13,10)256;	ATN line low (Command mode)
20 OUTPUT (13,10)512;	ATN line high (Data mode)
20 OUTPUT (13,10)768;	REN line low (Remote mode)
20 OUTPUT (13,10)1024;	REN line high (Local mode)
20 OUTPUT (13,10)1280;	Control flag true (Controller mode)
20 OUTPUT (13,10)1536;	Control flag false (Non-controller mode)

NOTES FOR TABLES 3-5 AND 3-6:

1. These statements function unconditionally, with respect to any prior programming, except as stated in Note 2.
2. Control flag must be true before ATN may be set low.
3. "Z" (9820A/21A) or semicolon (9830A) suppresses CR/LF characters.
4. "13" is the 59405A peripheral select code.

3-23. STATUS INPUT.

3-24. Status input is an indication of whether or not an instrument is requesting service and whether or not the 59405A is ready to send a character to the calculator. The 59405A is "ready" when it has been addressed to listen and has received and stored an input character from the bus that has not yet been transferred to the calculator by a program input statement. See Table 3-7 for the status codes and Table 3-3/3-4 for the status-function program mnemonic.

Table 3-7. Status Input Codes.

Status	Service Requested?	59405A Ready?
0	yes	no
1	yes	yes
2	no	no
3	no	yes

3-25. POWER-ON CONDITIONS.

3-26. At calculator power-on four events occur on the 59405A:

1. Control flag is set true making the calculator the active controller.
2. ATN line is pulled low giving the bus command mode.
3. Interface Clear signal unaddresses all devices on the bus, including the calculator.
4. REN line is pulled low giving the bus Remote mode.

3-27. STOP KEY.

3-28. Four events occur when the calculator STOP key is pressed (since the calculator is System Controller):

1. Control flag is set true making the calculator the active controller.
2. ATN line is pulled low giving the bus Command mode.
3. Interface Clear signal unaddresses all devices on the bus, including the calculator.
4. The calculator program stops.

3-29. INTERFACE CLEAR SIGNAL (IFC).

3-30. Interface Clear signal unaddresses all devices on the bus, including the calculator. It may be sent only by a System Controller. The calculator STOP key gives IFC. IFC from another System Controller sets the 59405A Control flag false and the ATN line high.

3-31. CHANGING THE LISTEN/TALK ADDRESSES.

3-32. The 59405A is shipped from the factory with its HP-IB listen and talk addresses set at "5" and "U" respectively. These may be changed to any listen/talk pair in Table 3-8 by repositioning the five jumper wires b1 thru b5 to give any one of the binary codes listed. Each of the 31 codes selects one fixed listen/talk address combination.

CAUTION

Only skilled maintenance personnel should change the instrument listen/talk addresses.

3-33. EXAMPLE PROGRAMS.

3-34. This section gives some example programs on accomplishing the basic tasks of controlling an instrument and taking measurement data from it with a Model 9820A, 9821A or 9830A calculator. The Model 3490A Multimeter is used in the examples, as it both "listens" and "talks". Both literal and variable techniques of instrument control and data printout are demonstrated.

3-35. 9820A/21A Literal Instrument Control.

3-36. Literal characters (characters within quotation marks) are used for instrument control when the control is to be constant at a given point in the program, not dependent upon prior program execution. Figure 3-2 shows how to examine the individual output characters of the 3490A. Figure 3-3 shows how to obtain a numeric readout on one constant range and function.

3-37. 9820A/21A Variable Instrument Control.

3-38. Variable values (values containing program variables) are used for instrument control when the control at a given point in the program is to be dependent upon prior program execution or input statements such as ENT. Figure 3-4 demonstrates not only variable instrument control but variable printout too, dependent upon the entire string of 3490A alphanumeric output characters.

3-39. 9830A Literal Instrument Control.

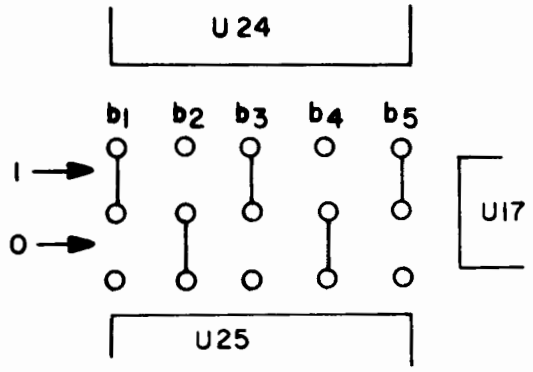
3-40. Literal characters (characters within quotation marks) are used for instrument control when the control is to be constant at a given point in the program, not dependent upon prior program execution. Figures 3-5 and 3-6 show how to examine the individual output characters of the 3490A. Figure 3-7 shows how to obtain a numeric readout on one constant range and function.

3-41. 9830A Variable Instrument Control.

3-42. Variable expressions (expressions containing program variables) are used for instrument control when the control at a given point in the program is to be dependent upon prior program execution or input statements such as INPUT. Figure 3-8 demonstrates not only variable instrument control but variable printout too, dependent upon the entire string of 3490A alphanumeric output characters.

Table 3-8. Address Codes Available.

Listen Address	Talk Address	Binary DI05 b_5	DI04 b_4	DI03 b_3	DI02 b_2	DI01 b_1
SP	@	0	0	0	0	0
!	A	0	0	0	0	1
"	B	0	0	0	1	0
#	C	0	0	0	1	1
$	D	0	0	1	0	0
%	E	0	0	1	0	1
&	F	0	0	1	1	0
'	G	0	0	1	1	1
(	H	0	1	0	0	0
)	I	0	1	0	0	1
*	J	0	1	0	1	0
+	K	0	1	0	1	1
,	L	0	1	1	0	0
-	M	0	1	1	0	1
.	N	0	1	1	1	0
/	O	0	1	1	1	1
0	P	1	0	0	0	0
1	Q	1	0	0	0	1
2	R	1	0	0	1	0
3	S	1	0	0	1	1
4	T	1	0	1	0	0
5 ←	U ←	1	0	1	0	1
6	V	1	0	1	1	0
7	W	1	0	1	1	1
8	X	1	1	0	0	0
9	Y	1	1	0	0	1
:	Z	1	1	0	1	0
;	[	1	1	0	1	1
<	\	1	1	1	0	0
=	]	1	1	1	0	1
>	^	1	1	1	1	0



← Factory selected address pair.

Table 3-9. 3490A Instruction Codes.

Character	Meaning
M	Mode-of-operation identifier
Ø	Addressed multi with no output
1	Addressed multi with output
2	Addressed single with no output
3	Addressed single with output
4	Interrupt multi with no output
5	Interrupt multi with output
6	Interrupt single with no output
7	Interrupt single with output
T	Trigger-source identifier
Ø	Internal sample rate
1	Immediate internal
2	Next external trigger
3	None

Character	Meaning
R	Range identifier
1	10,000 kΩ/test 7
2	1000 kΩ/1000 V/test 6
3	100 kΩ/100 V/test 5
4	10 kΩ/10 V/test 4
5	1 kΩ/1 V/test 3
6	.1 kΩ/.1 V/test 2
7	Autorange/test 1
F	Function identifier
Ø	DC volts
1	kilohms
2	AC volts
3	Test
E	End of present instruction string; execute the stored M,T,R and F instructions.

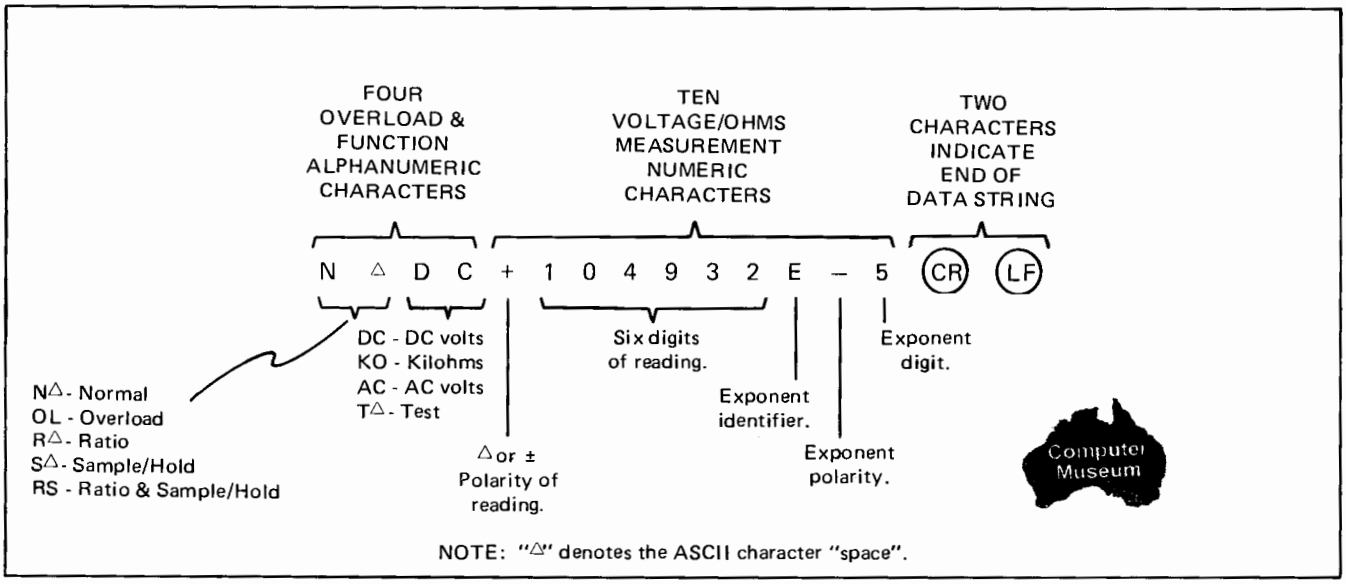


Figure 3-1. 3490A Output Format.

```
0:
FMT Y3,Z;WRT 13⊢
1:
CMD "?U6","R4FØT
1M3E","?5V"⊢
2:
FXD Ø;1→C⊢
3:
PRT RDB 13;JMP (
C+1→C)>14⊢
4:
CMD "→";FMT Y4,Z
;WRT 13⊢
5:
END ⊢
```

N	78
△	32
D	68
C	67
+	43
1	49
0	48
4	52
9	57
3	51
2	50
E	69
–	45
4	52

Line 0 - The bus REN line is pulled low (true).

Line 1 - In the first quote field, "U" addresses the calculator to talk and unaddresses all other talkers. "6" addresses the 3490A to listen; universal Unlisten command "?" preceding "6" assures that "6" is the *only* listener. Character "E" in the second quote field executes the "R4FØT1M3" instructions to trigger the 3490A once on the 10 V dc range. ("E" may be deleted and the instructions will be executed when the bus ATN line goes low with the third CMD quote field.) The third quote field addresses the calculator to listen, "5", and the 3490A to talk, "V", in preparation for sending the 3490A output characters to the calculator in program line 3.

Line 3 - RDB function is the only method to look at alphanumeric characters output by an instrument. Each time RDB is executed the talker (3490A) outputs its next character, and a decimal number equivalent to the ASCII binary code for that character is returned to the program. The JMP expression is false and returns the program to the beginning of line 3 (jump zero) until C is incremented to greater than 14, at which time the expression becomes true and jumps the program to line 4. The decimal codes of all fourteen 3490A output characters are printed.

Line 4 - "Y4" pulls the REN line high (false) to return the 3490A to local mode. However, a valid operating mode for the 3490A is for it to output readings on the bus in the local mode if it is addressed to talk. If the 3490A is addressed to talk and there is an addressed listener not ready to receive data (as is the calculator when not executing a RDB or RED statement) the 3490A is disabled from triggering even when it is returned to local control. By unaddressing the 3490A to talk with "→" (or a talk address other than the 3490A's) the 3490A will be able to trigger normally after it is put in the local mode by "Y4".

Figure 3-2. 9820A/21A Literal Instrument Control (Alphanumeric Code Printout).

```
0:
FMT Y3,Z;WRT 13⊢
1:
CMD "?U6","R4F0T
1M3E","?5V"⊢
2:
IF RDB 13=79;
PRT "OVERLOAD";
GTO 5⊢
3:
FMT *;RED 13,X⊢
4:
FXD 4;PRT "DC VO
LTS",X⊢
5:
CMD "→";FMT Y4,Z
;WRT 13⊢
6:
END ⊢


DC VOLTS
          10.4933
```

Line 2 - If the 3490A has taken an overloaded reading, its first output character will be the ASCII letter O (decimal number 79); the program will then print "OVERLOAD" and branch to line 5.

Line 3 - FMT/RED receive all numeric characters (such as digits, polarity signs, decimal point, "E") that have not been received by executions of RDB. The three remaining non-numeric characters preceding the numeric characters are skipped by RED under free-field format (*), so only the actual 3490A reading is assigned to variable X. RDB may be executed no more than four times previous to RED if the full 3490A reading, including the polarity sign, is to be received by X.

Line 4 - The 3490A reading is printed with the appropriate number of significant digits.

Figure 3-3. 9820A/21A Literal Instrument Control (Numeric Printout).

```
0:
FMT Y3,Z;WRT 13⊢
1:
CMD "?U6","T1M3"
⊢
2:
ENT "RANGE 1 TO
7?",A,"FUNCTION
1 TO 3?",B⊢
3:
FMT "R",FXD 1.0,
"F",FXD 1.0,"E",
Z⊢
4:
WRT 13,8-A,B(B≤2
)⊢
5:
CMD "?5V"⊢
6:
RDB 13→A;RDB 13→
B;RDB 13→B;RDB 1
3→C⊢
7:
IF A=79;PRT "OVE
RLOAD";GTO 13⊢
8:
IF B=68;PRT "DC
VOLTS";GTO 11⊢
9:
IF C=67;PRT "AC
VOLTS";GTO 11⊢
10:
PRT "KILOHMS"⊢
11:
FMT FXD 7.0,X,
FXD 2.0;RED 13,X
,Y⊢
12:
FXD -Y;PRT X10↑Y
⊢
13:
CMD "→";FMT Y4,Z
;WRT 13⊢
14:
END ⊢
```

```
DC VOLTS
          10.4931
```

Line 1 - Characters "?U6" address the calculator to talk and the 3490A to listen. The 3490A receives and stores the trigger source instruction "T1" and mode-of-operation "M3" but does not execute these instructions until it receives "E" in program line 3.

Line 2 - The 3490A range (1 thru 7) and function (1 thru 3) corresponding to the positions of the front panel switches are input by the operator and assigned to variables A and B respectively. Function 4 (TEST) is not considered in this example.

Lines 3, 4 - Five characters are sent to the 3490A: "R", range digit, "F", function digit, "E". Expressions 8-A and B (B ≤2) become the range and function instruction digits under format FXD 1.0 after they convert the 3490A front-panel switch positions to actual 3490A programming codes. "E" executes the instructions of lines 1, 3 and 4, that is, it causes the 3490A to take one reading on the range and function input in program line 2. "Z" suppresses the CR/LF characters.

Line 5 - The calculator is addressed to listen, "5", and the 3490A addressed to talk, "V", in preparation for sending the 3490A reading to the calculator in program lines 6 and 11.

Line 6 - Four executions of RDB assign the decimal code of the first, third and fourth 3490A alphanumeric output characters to variables A, B and C respectively.

Lines 7 thru 10 - A, B and C from line 6 are compared to ASCII characters O (79), D (68) and C (67) to print the function that the 3490A has taken a reading on.

Line 11 - The six digits and polarity of the 3490A reading are assigned to variable X under format FXD 7.0; character "E" is skipped by format specification "X"; the exponent digit and its sign are assigned to variable Y under format FXD 2.0.

Line 12 - The 3490A reading is printed with the decimal point positioned among the six digits by "10↑Y" and the number of decimal places determined by the exponent Y. This gives a printout with the correct number of significant digits.

Figure 3-4. 9820A/21A Variable Instrument Control (Numeric Printout).

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U6","R4F0T1M3E","?5V"
40 FOR C=1 TO 14
50 WRITE (15,10)RBYTE13;
60 NEXT C
70 PRINT
80 CMD "U"
90 OUTPUT (13,10)1024;
100 END


N DC+104930E-4
```

Lines 10, 20 - The bus REN line is pulled low (true).

Line 30 - In the first quote field, "U" addresses the calculator to talk and unaddresses all other talkers. "6" addresses the 3490A to listen; universal Unlisten command "?" preceding "6" assures that "6" is the *only* listener. Character "E" in the second quote field executes the "R4FØT1M3" instructions to trigger the 3490A once on the 10 V dc range. ("E" may be deleted and the instructions will be executed when the bus ATN line goes low at the third CMD quote field.) The third quote field addresses the calculator to listen, "5", and the 3490A to talk, "V", in preparation for sending the 3490A output characters to the calculator in program line 50.

Lines 40 thru 70 - RBYTE function allows individual alphanumeric output characters from an instrument to be examined. Each time RBYTE is executed the talker (3490A) outputs its next character, and a decimal number equivalent to the ASCII binary code for that character is returned to the program. WRITE sends the number returned by RBYTE to the 9866A Printer (peripheral select code 15) as an individual alphanumeric character under binary format B (line 10) each time the C loop is executed. The semicolon in line 50 prevents the usual CR/LF characters from being sent to the 9866A. The fourteen 3490A output characters are stored in the 9866A's line buffer until CR/LF are sent to the 9866A in line 70.

Line 80 - A valid operating mode for the 3490A is for it to output readings on the HP-IB in the local mode if it addressed to talk. If the 3490A is addressed to talk and there is an addressed listener not ready to receive data (as is the calculator when not executing an ENTER or RBYTE statement), the 3490A is disabled from triggering even when it is returned to local control. By addressing the calculator to talk, "U", at the end of the program, the 3490A becomes unaddressed to talk so that it will be able to trigger normally when it is put in the local mode in program line 90.

Line 90 - "1024" pulls the REN line high (false) to return the 3490A to local mode.

Figure 3-5. 9830A Literal Instrument Control (Alphanumeric Printout Using RBYTE).

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U6","R4F0T1M3E","?5V"
40 DIM A$[14]
50 ENTER (13,*)A$
60 PRINT A$
70 CMD "U"
80 OUTPUT (13,10)1024;
90 END


N DC+104932E-4
```

Lines 40 thru 50 - The fourteen 3490A output characters are assigned to string variable A$.

Figure 3-6. 9830A Literal Instrument Control (Alphanumeric Printout Using String Variables).

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U6","R4F0T1M3E","?5V"
40 FORMAT B,3X,E10.0
50 ENTER (13,40)Q,M
60 IF Q#79 THEN 90
70 PRINT "OVERLOAD"
80 GOTO 100
90 PRINT "DC VOLTS",M
100 CMD "U"
110 OUTPUT (13,10)1024;
120 END


DC VOLTS          10.4936
```

Lines 40, 50 - The ASCII coded, decimal number of the first 3490A alphanumeric output character is received by variable Q under format "B" (line 10). The next three output characters are skipped by "3X". The last ten numeric output characters are received by M as an exponentially formatted (E10.0) number representing the 3490A voltage measurement.

Lines 60 thru 80 - If the 3490A has taken an overloaded reading, its first output character will be the ASCII letter O (decimal number 79); the program will then print "OVERLOAD" and go to line 100.

Line 90 - The calculator Standard mode prints the 3490A reading, "M", in a fixed point format with the appropriate number of significant digits (except that trailing zeros are removed and readings under .01 V are changed to floating point format).

Figure 3-7. 9830A Literal Instrument Control (Numeric Printout).

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U6","T1M3"
40 DISP "RANGE 1 TO 7";
50 INPUT R
60 DISP "FUNCTION 1 TO 3";
70 INPUT F
80 FORMAT "R",F1000.0,"F",F1000.0,"E"
90 OUTPUT (13,80)8-R,F*(F<3);
100 CMD "?5V"
110 FORMAT B,X,2B,E10.0
120 ENTER (13,110)Q,D,C,M
130 IF Q#79 THEN 160
140 PRINT "OVERLOAD"
150 GOTO 230
160 IF D#68 THEN 190
170 PRINT "DC VOLTS",M
180 GOTO 230
190 IF C#67 THEN 220
200 PRINT "AC VOLTS",M
210 GOTO 230
220 PRINT "KILOHMS",M
230 CMD "U"
240 OUTPUT (13,10)1024;
250 END


DC VOLTS          10.4938
```

Line 30 - Characters "?U6" address the calculator to talk and the 3490A to listen. The 3490A receives and stores the trigger-source instruction "T1" and mode of operation "M3" but does not execute these instructions until it receives "E" in program line 80.

Lines 40 thru 70 - The 3490A range and function corresponding to the positions of the front panel switches are input by the operator and assigned to variables R and F respectively. Function 4 (TEST) is not considered in this example.

Lines 80, 90 - Five characters are sent to the 3490A: "R", range digit, "F", function digit, "E". Expressions 8-R and F*(F < 3) become the range and function instruction digits under format F1000.0 after they convert the 3490A front-panel switch positions to actual 3490A programming codes. "E" executes the instructions of lines 30, 80 and 90, that is, it causes the 3490A to take one reading on the range and function input in program lines 40 thru 70. The semicolon at the end of the OUTPUT statement suppresses the CR/LF characters.

Line 100 - The calculator is addressed to listen, "5", and the 3490A addressed to talk, "V", in preparation for sending the 3490A reading to the calculator in program lines 110, 120.

Lines 110, 120 - The ASCII coded, decimal number of the first, third and fourth alphanumeric output characters of the 3490A are received under format "B" by variables Q, D and C respectively. The second output character is skipped by "X". The last ten numeric output characters are received by M as an exponentially formatted (E10.0) number representing the 3490A voltage measurement.

Lines 160 thru 220 - Only one of the program lines 190, 200 or 220 will be executed according to whether the ASCII characters "D" and/or "C" have been assigned to variables D and C from the third and fourth 3490A output characters.

Figure 3-8. 9830A Variable Instrument Control (Numeric Printout).

WARNING

These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

SECTION IV
MAINTENANCE

4-1. PERFORMANCE VERIFICATION WITH 9820A.

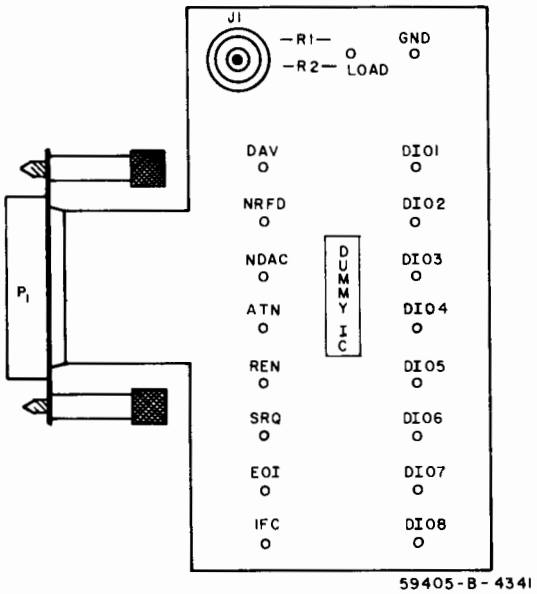
4-2. Recorded software is supplied with the 59405A to verify proper operation when used with a Model 9820A Calculator. The program, contained on magnetic cards -hp- Part No. 59405-90020, is secured.

4-3. EQUIPMENT REQUIRED.

4-4. The following equipment is required to accomplish performance verification.

a. Model 9820A Calculator – Option 001.
b. Model 11224A Peripheral Control II ROM.
c. Model 59405A HP-IB Calculator Interface.
d. 59405-66503 Test Card (Figure 4-1).
e. 59405-90020 Magnetic Cards.
f. Clip Leads, 4 (-hp- Part No. 5061-0753).
g. + 5 V Power Supply (with BNC cable) or calculator extender board 5061-0726 (which has a + 5 V supply BNC terminal).

4-5. The program is divided into two sections so that it can be run on a Model 9820A Calculator having only 429 registers of memory. The Peripheral Control II ROM allows operation of the 59405A. A test card provides access to the individual HP-IB lines. A + 5 V power supply is desirable but not necessary; it enables the 59405A to be tested under a load. Jumpers are used to connect pins on the test card.



-hp- Part No. 59405-66503
Rev. A

Figure 4-1. HP-IB Test Card.

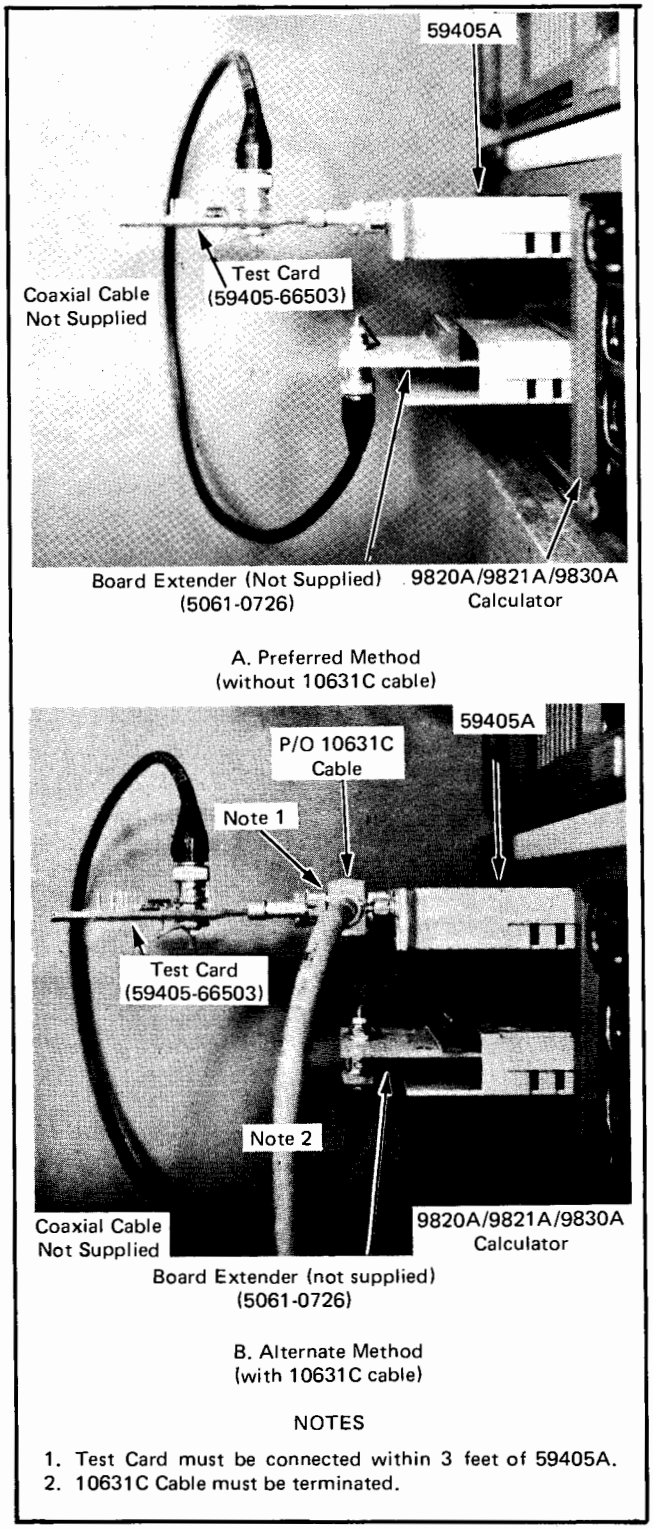


Figure 4-2. Equipment Interconnections.

4-6. INITIAL CONNECTIONS.

4-7. Change the address jumpers on the 59405A to the "5U" combination if they have been changed from the factory setting; see Table 3-8. *Turn the Calculator LINE OFF* and insert the 59405A into any slot on the rear of the 9820A. Connect the 59405-66503 test card directly to the 59405A. (A three foot cable, 10631A, may be used between the test card and the 59405A, but any longer cable may make the program fail. No other device is to be connected to the 59405A.) If a + 5 V power supply is to be used connect it to the BNC connector (center conductor high) on the test card. A calculator extender board 5061-0726 may be used for the power supply.

4-8. PROCEDURE.

NOTES

Parentheses on the printout indicate calculator keys that must be pressed.

Certain pins on the test card must be connected at various times with jumpers as indicated by (pin = pin) on the printout. Each new printout indicating one, two or three jumper positions is an updated list of the total number of jumpers required at that program step. (A new printout is recognized by a skipped line on the printout.) Be sure to remove any previously connected jumpers that are not reprinted in the latest printout of jumper positions. Do not make any jumper changes until the next jumper positions or "NO JUMPERS" is printed.

CAUTION

Incorrect jumper arrangements may make the 59405A appear defective.

4-9. If the + 5 V power supply is to be used, connect a jumper from the LOAD pin to the SRQ pin on the test card for all tests except the Data Input Test; then connect the jumper between the LOAD and REN pins.

4-10. After the one or more jumpers have been arranged on the test card according to the printout, press the RUN-PROGRAM key to continue the program.

4-11. There are seven separate tests in the verification program. After each test is completed, whether it passes or fails, you may rerun the same test or go to the next test by pressing 0 RUNPROGRAM or 1 RUNPROGRAM respectively. If a test fails and it cannot be made to pass by re-running it, then the program ends when 1 RUNPROGRAM are pressed.

4-12. If certain 59405A circuits or the calculator I/O is defective, the calculator will "hang up". This is apparent when the calculator fails to respond with a printout or display within two seconds, or within the run time given on the printout, after you press RUNPROGRAM. In this event press the four keys STOP GOTO 4 RUNPROGRAM.

4-13. RUNNING THE PROGRAM.

a. Turn the calculator LINE OFF, wait 10 seconds, then turn the LINE ON.

b. Press the two keys LOAD EXECUTE. Insert sides 1A through 5A of the program cards into the calculator. "NOTE 14" means that the EXECUTE key must be pressed again and the next card side inserted.

c. Press the two keys END RUNPROGRAM and follow the instructions on the printout. Press the calculator keys that are indicated by parentheses on the printout. After the first three tests you will be required to insert sides 1B through 5B of the program cards into the calculator.

4-14. If all seven tests pass and the 1 RUNPROGRAM keys are pressed after the seventh test, "59405A IS OPERATING CORRECTLY" will be printed. If any test fails, "INCORRECT RESPONSE AT HP-IB INTERFACE" will be printed; if you then press 1 RUNPROGRAM for the next test as in Paragraph 4-11, the program will end. The latter message may mean that the calculator, PC II ROM, 59405A, test card or a jumper is defective.

4-15. Control Test.

4-16. The Control Turn-On, Stop, SRQ, ATN, REN and IFC functions are tested here.

4-17. If the calculator was turned off before the program was loaded and none of the seven tests have been run since turn-on, then it is not necessary to follow the first two instructions in the Control Test; just press the three keys GOTO 3 RUNPROGRAM according to the third instruction.

4-18. Further emphasis on the understanding of jumper positions is given below.

a. Only one jumper (other than the load jumper) is to be installed on the test card at any one time during the Control Test until "ATN = SRQ" and "IFC = GND" appear together on adjacent printout lines.

b. The IFC-to-GND jumper is to be removed when "ATN = SRQ" is printed by itself on the next printout.

4-19. Select Code Test.

4-20. The ability of the 59405A to respond to only select code 13 is tested here.

4-21. Press the two keys STOP RUNPROGRAM four times as indicated by the printout.

4-22. Addressing Test.

4-23. The ability of the 59405A to recognize its talk, untalk, listen and unlisten addresses and ignore all other codes in the HP-IB Command mode is tested here. The Command mode handshake is also tested.

4-24. Press the two keys STOP RUNPROGRAM five times as indicated by the printout.

4-25. Listen Handshake Test.

4-26. The ability of the 59405A to operate the NRFD and NDAC lines and respond to the DAV line is tested here; it is also a more thorough test of SRQ.

4-27. Data Input Test.

4-28. The ability of the 59405A to input data is tested here.

4-29. Move the load jumper so that it is between the LOAD and REN pins for the duration of this test.

4-30. Talk Handshake Test.

4-31. The ability of the 59405A to operate the DAV line and respond to the NRFD and NDAC lines is tested here.

4-32. At one point during this test three jumpers (other than the load jumper) are required on the test card.

4-33. Data Output Test.

4-34. The ability of the 59405A to output data is tested here. All DIO lines are tested for each possible output character.

4-35. RUNNING INDIVIDUAL TESTS.

4-36. Individual tests out of the total seven in the verification program may be run if it is desirable to retest only certain functions of the 59405A. The program ends after each test except the Control Test.

4-37. The individual tests may be run by loading only the A or B sides of the program cards. Press END EXECUTE LOAD EXECUTE; insert the A or B sides of the cards and press the keys given below:

a. Control Test – Load and run the A sides as previously described under RUNNING THE PROGRAM. Press STOP at the end of the test.

b. Select-Code Test – Sides 1A through 5A. Press GOTO 3 3 RUN PROGRAM.

c. Addressing Test – Sides 1A through 5A. Press GOTO 4 4 RUNPROGRAM.

d. Listen Handshake Test – Sides 1B through 5B. Press END RUNPROGRAM.

e. Data Input Test – Sides 1B through 5B. Press GOTO 2 8 RUNPROGRAM.

f. Talk Handshake Test – Sides 1B through 5B. Press GOTO 4 4 RUNPROGRAM.

g. Data Output Test – Sides 1B through 5B. Press END EXECUTE GOTO 6 5 RUNPROGRAM.

4-38. PERFORMANCE VERIFICATION WITH 9821A.

4-39. Recorded software is supplied with the 59405A to verify proper operation when used with a Model 9821A Calculator. The program, contained on a tape cassette -hp- Part No. 59405-90021, is secured.

4-40. EQUIPMENT REQUIRED.

4-41. The following equipment is required to accomplish performance verification.

a. Model 9821A Calculator, Option 001.
b. Model 11224A Peripheral Control II ROM.
c. Model 59405A HP-IB Calculator Interface.
d. 59405-66503 Test Card (Figure 4-1).
e. 59405-90021 Cassette.
f. Clip Leads, 4 (-hp- Part No. 5061-0753).
g. + 5 V Power Supply (with BNC cable) or calculator extender board 5061-0726 (which has a + 5 V supply BNC terminal).

4-42. The program is divided into two sections so that it can be run on a Model 9821A Calculator having only 423 registers of memory. The Peripheral Control II ROM allows operation of the 59405A. A test card provides access to the individual HP-IB lines. A + 5 V power supply is desirable but not necessary; it enables the 59405A to be tested under a load. Jumpers are used to connect pins on the test card.

4-43. INITIAL CONNECTIONS.

4-44. Change the address jumpers on the 59405A to the "5U" combination if they have been changed from the factory setting; see Table 3-8. *Turn the calculator LINE OFF* and insert the 59405A into any slot on the rear of the 9821A. Connect the 59405-66503 test card directly to the 59405A. (A three foot cable, 10631A, may be used between the test card and the 59405A, but any longer cable may make the program fail. No other device is to be connected to the 59405A.) If a + 5 V power supply is to be used, connect it to the BNC connector (center conductor high) on the test card. A calculator extender board 5061-0726 may be used for the power supply.

4-45. PROCEDURE.

NOTES

Parentheses on the printout indicate calculator keys that must be pressed

Certain pins on the test card must be connected at various times with jumpers as indicated by (pin = pin) on the printout. Each new printout indicating one, two or three jumper positions is an updated list of the total number of jumpers required at that program step. (A new printout is recognized by a skipped line on the printout.) Be sure to remove any previously connected jumpers that are not reprinted in the latest printout of jumper positions. Do not make any jumper changes until the next jumper positions or "NO JUMPERS" is printed.

CAUTION

Incorrect jumper arrangements may make the 59405A appear defective.

4-46. If the + 5 V power supply is to be used, connect a jumper from the LOAD pin to the SRQ pin on the test card for all tests except the Data Input Test; then connect the jumper between the LOAD and REN pins.

4-47. After the one or more jumpers have been arranged on the test card according to the printout, press the RUNPROGRAM key to continue the program.

4-48. There are seven separate tests in the verification program. After each test is completed, whether it passes or fails, you may rerun the same test or go to the next test by pressing 0 RUNPROGRAM or 1 RUNPROGRAM respectively. If a test fails and it cannot be made to pass by rerunning it, then the program ends when 1 RUNPROGRAM are pressed.

4-49. If certain 59405A circuits or the calculator I/O is defective the calculator will "hang up". This is apparent when the calculator fails to respond with a printout or display within two seconds, or within the run time given on the printout, after you press RUNPROGRAM. In this event press the four keys STOP GOTO 4 RUNPROGRAM.

4-50. RUNNING THE PROGRAM.

CAUTION

Never turn LINE OFF while the cassette is in the calculator unless the cassette has been rewound. It will normally rewind automatically.

a. Turn the calculator LINE OFF, wait 10 seconds, then turn the LINE ON.

b. Insert the 59405-90021 cassette into the calculator.

c. Press the five keys END EXECUTE LDF 0 EXECUTE. Wait for the tape to stop.

NOTE

The program is recorded three times on the cassette. The other two recordings may be accessed by LDF 2 or LDF 4.

d. Press the two keys END RUNPROGRAM and follow the instructions on the printout.

4-51. If all seven tests pass and the 1 RUNPROGRAM keys are pressed after the seventh test, "59405A IS OPERATING CORRECTLY" will be printed. If any test fails, "INCORRECT RESPONSE AT HP-IB INTERFACE" will be printed; if you then press 1 RUNPROGRAM for the next test as in Paragraph 4-48, the program will end. The latter message may mean that the calculator, PC II ROM, 59405A, test card or a jumper is defective.

4-52. Control Test.

4-53. The Control, Turn-On, Stop, SRQ, ATN, REN and IFC functions are tested here.

4-54. If the calculator was turned off before the program was loaded and none of the seven tests have been run since turn-on, then it is not necessary to follow the first two instructions in the Control Test; just press the three keys GOTO 3 RUNPROGRAM according to the third instruction.

4-55. Further emphasis on the understanding of jumper positions is given below.

a. Only one jumper (other than the load jumper) is to be installed on the test card at any one time during the Control Test until "ATN = SRQ" and "IFC = GND" appear together on adjacent printout lines.

b. The IFC-to-GND jumper is to be removed when "ATN = SRQ" is printed by itself on the next printout.

4-56. Select Code Test.

4-57. The ability of the 59405A to respond to only select code 13 is tested here.

4-58. Press the two keys STOP RUNPROGRAM four times as indicated by the printout.

4-59. Addressing Test.

4-60. The ability of the 59405A to recognize its talk, untalk, listen and unlisten addresses and ignore all other codes

in the HP-IB Command mode is tested here. The Command mode handshake is also tested.

4-61. Press the two keys STOP RUNPROGRAM five times as indicated by the printout.

4-62. Listen Handshake Test.

4-63. The ability of the 59405A to operate the NRFD and NDAC lines and respond to the DAV line is tested here; it is also a more thorough test of SRQ.

4-64. Data Input Test.

4-65. The ability of the 59405A to input data is tested here.

4-66. Move the load jumper so that it is between the LOAD and REN pins for the duration of this test.

4-67. Talk Handshake Test.

4-68. The ability of the 59405A to operate the DAV line and respond to the NRFD and NDAC lines is tested here.

4-69. At one point during this test three jumpers (other than the load jumper) are required on the test card.

4-70. Data Output Test.

4-71. The ability of the 59405A to output data is tested here. All DIO lines are tested for each possible output character.

4-72. RUNNING INDIVIDUAL TESTS.

4-73. Individual tests out of the total seven in the verification program may be run if it is desirable to retest only certain functions of the 59405A. The program ends after each test except the Control Test.

4-74. The individual tests may be run by loading the appropriate file and running the program at the points given below:

a. Control Test – Press END EXECUTE LDF (0, 2 or 4), then END RUNPROGRAM. Press STOP at the end of the test.

b. Select-Code Test – Press END EXECUTE LDF (0, 2 or 4) EXECUTE, then GOTO 3 3 RUNPROGRAM.

c. Addressing Test – Press END EXECUTE LDF (0, 2 or 4) EXECUTE, then GOTO 4 4 RUNPROGRAM.

d. Listen Handshake Test – Press END EXECUTE LDF (1, 3 or 5) EXECUTE, then END RUNPROGRAM.

e. Data Input Test – Press END EXECUTE LDF (1, 3 or 5) EXECUTE, then GOTO 2 8 RUNPROGRAM.

f. Talk Handshake Test – Press END EXECUTE LDF (1, 3 or 5) EXECUTE, then GOTO 4 4 RUNPROGRAM.

g. Data Output Test – Press END EXECUTE LDF (1, 3 or 5) EXECUTE, then GOTO 6 5 RUNPROGRAM.

4-75. PERFORMANCE VERIFICATION WITH 9830A.

4-76. Recorded software is supplied with the 59405A to verify proper operation when used with a Model 9830A Calculator. The program, contained on a tape cassette -hp- Part No. 59405-90030, is secured.

4-77. EQUIPMENT REQUIRED.

4-78. The following equipment is required to accomplish performance verification.

a. Model 9830A Calculator.
b. Model 11272B Extended I/O ROM.
c. Model 59405A HP-IB Calculator Interface.
d. 59405-66503 Test Card (Figure 4-1).
e. 59405-90030 Cassette.
f. Clip Leads, 4 (-hp- Part No. 5061-0753).
g. + 5 V Power Supply (with BNC cable) or calculator extender board 5061-0726 (which has a + 5 V supply BNC terminal).

4-79. The program is divided into two files so that it can be run on a Model 9830A Calculator having only 1760 words of memory. The Extended I/O ROM allows operation of the 59405A. A test card provides access to the individual HP-IB lines. A + 5 V power supply is desirable but not necessary; it enables the 59405A to be tested under a load. Jumpers are used to connect pins on the test card.

4-80. INITIAL CONNECTIONS.

4-81. Change the address jumpers on the 59405A to the "5U" combination if they have been changed from the factory setting; see Table 3-8. *Turn the calculator LINE OFF* and insert the 59405A into any slot on the rear of the 9830A. Connect the 59405-66503 test card directly to the 59405A. (A three foot cable, 10631A, may be used between the test card and the 59405A, but any longer cable may make the program fail. No other device is to be connected to the 59405A.) If a + 5 V power supply is to be used connect it to the BNC connector (center conductor high) on the test card. A calculator extender board 5061-0726 may be used for the power supply.

4-82. PROCEDURE.

NOTES

Parentheses on the printout indicate calculator keys that must be pressed

Certain pins on the test card must be connected at various times with jumpers as indicated by (pin = pin) on the printout. Each new printout indicating one, two or three jumper positions is an updated list of the total number of jumpers required at that program step. (A new printout is recognized by a skipped line on the printout.) Be sure to remove any previously connected jumpers that are not reprinted in the latest printout of jumper positions. Do not make any jumper changes until the next jumper positions or "NO JUMPERS" is printed.

CAUTION

Incorrect jumper arrangements may make the 59405A appear defective.

4-83. If the + 5 V power supply is to be used, connect a jumper from the LOAD pin to the SRQ pin on the test card for all tests except the Data Input Test; then connect the jumper between the LOAD and REN pins.

4-84. After the one or more jumpers have been arranged on the test card according to the printout, press the CONT EXECUTE keys to continue the program.

4-85. There are seven separate tests in the verification program. After each test is completed, whether it passes or fails, you may rerun the same test or go to the next test by pressing 0 EXECUTE or 1 EXECUTE respectively. If a test fails and it cannot be made to pass by rerunning it, then the program ends when 1 EXECUTE are pressed.

4-86. If certain 59405A circuits or the calculator I/O is defective the calculator will "hang up". This is apparent when the calculator fails to respond with a printout or display within three seconds, or within the run time given on the printout, after you press CONT EXECUTE. In this event press the five keys STOP CONT 4 0 EXECUTE.

4-87. RUNNING THE PROGRAM.

CAUTION

Never turn LINE OFF while the cassette is in the calculator unless the cassette has been rewound. It will normally rewind automatically.

a. Turn the calculator LINE OFF, wait 10 seconds, then turn the LINE ON.

b. Insert the 59405-90030 cassette into the calculator.

c. Press the two keys LOAD EXECUTE. Wait for the tape to stop.

NOTE

The program is recorded three times on the cassette. The other two recordings may be used by pressing LOAD 2 EXECUTE or LOAD 4 EXECUTE.

NOTE

A list of general procedures is printed at the beginning of the program. To skip this press RUN 5 0 EXECUTE.

e. Follow the instructions printed by the program. Press the calculator keys indicated by parentheses on the printout.

4-88. If all seven tests pass and the 1 EXECUTE keys are pressed after the seventh test, "59405A IS OPERATING CORRECTLY" will be printed. If any test fails, "INCORRECT RESPONSE AT HP-IB INTERFACE" will be printed: if you then press 1 EXECUTE for the next test as in Paragraph 4-85, the program will end. The latter message may mean that the calculator, EXTENDED I/O ROM, 59405A, test card or a jumper is defective.

4-89. Control Test.

4-90. The Control, Turn-On, Stop, SRQ, ATN, REN and IFC functions are tested here.

4-91. If the calculator was turned off before the program was loaded and none of the seven tests have been run since turn-on, then it is not necessary to follow the second and third instructions in the Control Test; just press the four keys CONT 3 0 EXECUTE according to the fourth instruction.

4-92. Now further emphasis on the understanding of jumper positions:

Only one jumper (other than the load jumper) is to be installed on the test card at any one time during the Control Test until "ATN = SRQ" and "IFC = GND" appear together on adjacent printout lines. The IFC-to-GND jumper is to be removed when "ATN = SRQ" is printed by itself on the next printout.

4-93. Select Code Test.

4-94. The ability of the 59405A to respond to only select code 13 is tested here.

4-95. Press the three keys STOP CONT EXECUTE three times as indicated by the printout.

4-96. Addressing Test.

4-97. The ability of the 59405A to recognize its talk, untalk, listen and unlisten addresses and ignore all other codes in the HP-IB Command mode is tested here. The Command mode handshake is also tested.

4-98. Press the three keys STOP CONT EXECUTE five times as indicated by the printout.

4-99. Listen Handshake Test.

4-100. The ability of the 59405A to operate the NRFD and NDAC lines and respond to the DAV line is tested here; it is also a more thorough test of SRQ.

4-101. Data Input Test.

4-102. The ability of the 59405A to input data is tested here.

4-103. Move the load jumper so that it is between the LOAD and REN pins for the duration of this test.

4-104. Talk Handshake Test.

4-105. The ability of the 59405A to operate the DAV line and respond to the NRFD and NDAC lines is tested here.

4-106. At one point during this test three jumpers (other than the load jumper) are required on the test card.

4-107. Data Output Test.

4-108. The ability of the 59405A to output data is tested here. All DIO lines are tested for each possible output character.

4-109. RUNNING INDIVIDUAL TESTS.

4-110. Individual tests out of the total seven in the verification program may be run if it is desirable to retest only certain functions of the 59405A. The program ends after each test except the Control Test.

4-111. The individual tests may be run by loading the appropriate file and running the program at the points given below:

a. Control Test – Press LOAD (0, 2 or 4) EXECUTE, then RUN 5 0 EXECUTE. Press STOP at the end of the test.

b. Select-Code Test – Press LOAD (0, 2 or 4) EXECUTE, then RUN 6 0 0 EXECUTE.

c. Addressing Test – Press LOAD (0, 2 or 4) EXECUTE, then RUN 7 3 0 EXECUTE.

d. Listen Handshake Test – Press LOAD (1, 3 or 5) EXECUTE, then RUN EXECUTE.

e. Data Input Test – Press LOAD (1, 3 or 5) EXECUTE, then RUN 3 5 0 EXECUTE.

f. Talk Handshake Test – Press LOAD (1, 3 or 5) EXECUTE, then RUN 5 2 0 EXECUTE.

g. Data Output Test – Press LOAD (1, 3 or 5) EXECUTE, then RUN 8 2 0 EXECUTE.

4-112. HP-IB TEST CARD.

4-113. The HP-IB test card, shown in Figure 4-1, allows easy access to the bus lines. The test card provides the following:

a. A separate test point for each of the 16 active bus lines, plus a ground test point.

g. A 16-pin DIP (dual in-line package) dummy IC for use with an IC test clip (not supplied). This clip allows a logic scope, such as Hewlett-Packard Model 1601L Logic State Analyzer, to easily monitor bus signals. The high-to-low transition of DAV or NRFD may be used as the scope CLOCK INPUT.

c. A BNC connector for easy application of + 5 V dc to the test card. The + 5 volts is applied to the:

1. Dummy IC so the bus can be monitored by a logic clip.

2. LOAD test point which can be used to simulate 14 TTL loads. (All sources or talkers are required to handle 14 TTL loads.)

4-114. LOAD TEST POINT USE.

4-115. Using a clip lead supplied, a bus line to be tested is jumpered to the LOAD test point. The bus line is activated (pulled low) and the TTL voltage level (low) is checked using a voltmeter. The acceptable TTL logic levels are as follows:

a. True State – 0 V dc to + 0.4 V dc.

b. False State – + 2.5 V dc to + 5 V dc.

4-116. ACTIVATING THE BUS LINES.

4-117. The IFC, EOI, and SRQ lines cannot be activated (pulled low) from a calculator program. The remaining bus lines are activated as follows:

a. ATN and REN Lines. These lines can be tested by using the statements in Tables 3-5 and 3-6 and the notes given for these tables.

b. Data Lines DIO1 through DIO8. The programs shown in Figure 4-3 sequentially activate (pull low) the data lines starting with DIO1. The time interval between each activity can be changed as follows (refer to Figure 4-3):

1. 9820A/9821A program – Increase or decrease the number (800) given in Line 3.

2. 9830A Program – Increase or decrease the number (10,000) given in Line 40.

CALCULATOR

9820A/21A

```
0:
FMT Y5,2;WRT 13+
1:
0→A+
2:
WTB 13,A+
3:
IF (X+1→X)=80;CT
→X;JMP 2+
4:
JMP -1+
5:
IF A=128;WTB 13,
0;JMP 4+
6:
20→A+
7:
IF A=0;A+1→A+
8:
JMP -6+
9:
DSP "END";END !
Z20@!
R385
```

9830A

```
10 FORMAT 2B
20 OUTPUT (13,10)1280,0;
30 FOR I=0 TO 8
40 WAIT 10000
50 OUTPUT (13,10)2↑I;
60 NEXT I
70 OUTPUT (13,10)0;
80 DISP "END";
90 END
```

Figure 4-3. Data Lines Programs.

4-118. MONITORING THE BUS LINES.

4-119. Each byte transferred on the HP-IB data lines employs the 3-wire (DAV, NRFD and NDAC "Handshake" sequence. The Handshake depends on the state of the lines and is not dependent upon "edge" triggering or transition. The Handshake sequence has the following characteristics:

a. Data transfer is asynchronous – Data can be transferred at any rate suitable for the devices operating on the Bus. Data rates up to 500 kilobytes/second are typical, with a maximum of 1 megabyte/second.

b. Devices having different input/output speeds can be interconnected. Data transfer rate automatically adjusts to the slowest active device.

c. More than one device can accept data simultaneously.

4-120. Each data byte is transmitted on the data lines under sequential control of the three "Handshake" lines. No event in the sequence can be initiated until the previous event is completed. Data byte transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device. This allows devices with different input/output speeds to be interconnected on the HP-IB. A simple "Handshake" sequence of events is illustrated and described in Figure 4-4.

4-121. BOARD EXCHANGE.

4-122. A rebuilt printed circuit assembly is available on an exchange basis under part number 11144-69501.

CAUTION

An assembly with visible damage to the printed circuit board is not acceptable for exchange.

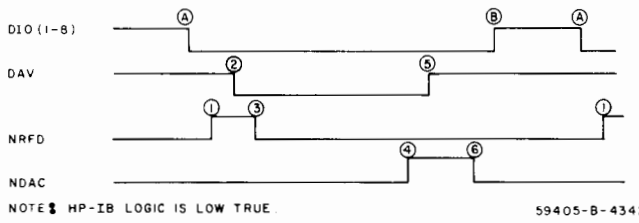
4-123. REPAIR.

CAUTION

The multi-layer plated-through printed circuit board can be easily damaged by excessive heat or force on the printed circuit traces.

4-124. Equipment.

4-125. An extender board 5061-0726 allows the 59405A to be operated outside of the calculator for troubleshooting. A 5 volt BNC terminal on the extender board



EVENT	REMARKS
Ⓐ AND Ⓑ	— THE INTERVAL BETWEEN Ⓐ AND Ⓑ INDICATES WHEN ONE 8 BIT BYTE OF INFORMATION IS PRESENT ON THE DATA LINES (DIO1-DIO8).

NOTE

FOR THE REMAINDER OF THIS EXPLANATION, THE TERM "DATA" REFERS TO ONE BYTE OF INFORMATION.

NRFD GOES FALSE	— Acceptor indicates readiness to receive data.
DAV GOES TRUE	— Source has recognized NRFD FALSE and indicates to the acceptor that the data is valid.
NRFD GOES TRUE	— Acceptor recognizes data is valid. DAV has gone TRUE and indicates to source an unreadiness to receive new data. The acceptor accepts the data on the DIO Lines to store internally after NRFD goes TRUE.
NDAC GOES FALSE	— Acceptor indicates to source that he has stored internally the data on DIO Lines. After data is stored, internal processing begins.
DAV GOES FALSE	— Source recognizes that the acceptor has set NDAC FALSE. Source removes data valid indication by setting DAV FALSE in preparation for placing next character on DIO Lines.
NDAC GOES TRUE	— Acceptor recognizes that the source has acknowledged its acceptance of the data and removes the data accepted indication. Acceptor continues to process the internally stored data.
NRFD GOES FALSE	— When acceptor completes processing the internally stored data, the acceptor sets NRFD FALSE which indicates readiness to receive the next byte.

NOTE

Events ① through ⑥ must occur for **each** *byte of information transferred between devices on the HP-IB.*

Figure 4-4. Handshake Sequence of Events.

provides power for a Model 10525T Logic Probe. Other equipment is listed in paragraphs 4-4, 4-41, and 4-78.

4-126. Soldering.

4-127. Observe the following general rules when replacing a component:

a. Use a temperature controlled (700° F) soldering iron having a pointed tip, and a small diameter rosin core solder.

b. Use needle-nose pliers to remove each component lead as the lead is heated.

CAUTION

Use of a solder sucker or excessive heat may separate the printed circuit trace from the board.

c. If a hole becomes plugged with solder after the lead is removed, then clean the hole with a toothpick while applying heat.

d. Shape the leads of the new component and insert them into the holes.

e. Solder the leads so that the solder flows through the hole. Do not use excessive solder or apply heat any longer than necessary.

f. Remove any excess flux from the area.

SECTION V
REPLACEABLE PARTS

5-1. INTRODUCTION.

5-2. This section contains information for ordering replacement parts. Table 5-3 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Description of the part. (See list of abbreviations in Table 5-1.)

b. Typical manufacturer of the part in a five-digit code. (See Table 5-2 for list of manufacturers.)

c. Manufacturer's part number.

5-3. ORDERING INFORMATION.

5-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix A for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

5-5. NON-LISTED PARTS.

5-6. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

Table 5-1. Standard Abbreviations.

ABBREVIATIONS

Ag	silver	Hz	hertz (cycle(s) per second)	NPO	negative positive zero (zero temperature coefficient)	sl	slide
Al	aluminum					SPDT	single-pole double-throw
A	ampere(s)	ID	inside diameter	ns	nanosecond(s) = 10^{-9} seconds	SPST	single-pole single-throw
Au	gold	impg	impregnated	nsr	not separately replaceable		
		incd	incandescent			Ta	tantalum
C	capacitor	ins	insulation(ed)	Ω	ohm(s)	TC	temperature coefficient
cer	ceramic			obd	order by description	TiO_2	titanium dioxide
coef	coefficient	kΩ	kilohm(s) = 10^{+3} ohms	OD	outside diameter	tog	toggle
com	common	kHz	kilohertz = 10^{+3} hertz			tol	tolerance
comp	composition			p	peak	trim	trimmer
conn	connection	L	inductor	pA	picoampere(s)	TSTR	transistor
		lin	linear taper	pc	printed circuit		
dep	deposited	log	logarithmic taper	pF	picofarad(s) 10^{-12} farads	V	volt(s)
DPDT	double-pole double-throw			piv	peak inverse voltage	vacw	alternating current working voltage
DPST	double-pole single-throw	mA	milliampere(s) = 10^{-3} amperes	p/o	part of	var	variable
		MHz	megahertz = 10^{+6} hertz	pos	position(s)	vdcw	direct current working voltage
elect	electrolytic	MΩ	megohm(s) = 10^{+6} ohms	poly	polystyrene		
encap	encapsulated	met flm	metal film	pot	potentiometer	W	watt(s)
		mfr	manufacturer	p-p	peak-to-peak	w/	with
F	farad(s)	ms	millisecond	ppm	parts per million	wiv	working inverse voltage
FET	field effect transistor	mtg	mounting	prec	precision (temperature coeffient, long term stability and/or tolerance)	w/o	without
fxd	fixed	mV	millivolt(s) = 10^{-3} volts			ww	wirewound
		μF	microfarad(s)				
GaAs	gallium arsenide	μs	microsecond(s)	R	resistor		
GHz	gigahertz = 10^{+9} hertz	μV	microvolt(s) = 10^{-6} volts	Rh	rhodium	*	optimum value selected at factory, average value shown (part may be omitted)
gd	guard(ed)	my	Mylar®	rms	root-mean-square	**	no standard type number assigned selected or special type
Ge	germanium			rot	rotary		
gnd	ground(ed)	nA	nanoampere(s) = 10^{-9} amperes				
		NC	normally closed	Se	selenium		
H	henry(ies)	Ne	neon	sect	section(s)	®	Dupont de Nemours
Hg	mercury	NO	normally open	Si	silicon		

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

STD-B-2734

DESIGNATORS

A	assembly	FL	filter	Q	transistor	TS	terminal strip
B	motor	HR	heater	QCR	transistor-diode	U	microcircuit
BT	battery	IC	integrated circuit	R	resistor	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	RT	thermistor	W	cable
CR	diode	K	relay	S	switch	X	socket
DL	delay line	L	inductor	T	transformer	XDS	lampholder
DS	lamp	M	meter	TB	terminal board	XF	fuseholder
E	misc electronic part	MP	mechanical part	TC	thermocouple	Y	crystal
F	fuse	P	plug	TP	test point	Z	network

Table 5-2. Code List of Manufacturers.

Code No.	Manufacturer	Address
00779	Amp. Inc.	Harrisburg, PA
01121	Allen Bradley Co.	Milwaukee, WI 53212
01295	Texas Instr. Inc. Semicond. Component Division	Dallas, TX 75231
02660	Amphenol-Borg Electronics Corp.	Broadview, IL
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, NJ 08876
04713	Motorola Inc. Semiconductor Prod. Division	Phoenix, AZ 85008
12040	National Semiconductor Corp.	Danbury, CN
14433	ITT Semiconductor, Div. of Int. Telephone & Telegraph	West Palm Beach, FL
14674	Corning Glass Works	Corning, NY
28480	Hewlett-Packard Co.	Palo Alto, CA 94304
56289	Sprague Electric Co.	North Adams, MA 01247
72136	Electro Motive Mfg. Co. Inc.	Willimantic, CT 06226
82170	Fairchild Camera & Inst. Corp	Paramus, NJ 07652
91418	Radio Materials Co.	Chicago, IL
91637	Dale Electronics Inc.	Columbus, NE 68601

Table 5-3. Replaceable Parts.

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	**11144-66501**	**1**	**PC Ass'y:HP-IB CALCULATOR INTERFACE**	**-hp-**	
	11144-69501		**Rebuilt Exchange**		
C1	0180-0228	1	C: fxd 22 µF 15 vdcw ± 10%	56289	150D226X9015B2-DYS
C2 thru C4	0150-0093	5	C: fxd cer .01 µF 100 vdcw - 20 + 80%	91418	TA Type 801-K800011
C5	0160-0157	1	C: fxd mylar .0047 µF 200 vdcw ± 10%	56289	292P47292-PTS
C6	0140-0176	1	C: fxd mica 100 pF 300 V ± 2%	72136	obd
C7	0180-1704	1	C: fxd solid Ta 47 µF 6 vdcw ± 10%	56289	150D476X9006B2-DYS
C8, C9	0150-0093		C: fxd cer .10 µF 100 V	91418	TA Type 801-K800011
C10	0140-0149	1	C: fxd mica 470 pF 300 V ± 5%	72136	obd
CR1	1901-0040	1	Diode: Si .05 A 30 V	01295	PG512
CR2	1910-0016	1	Diode: Ge 60 V	14433	14433
U1	1820-0583	8	U: dgtl DM74L00N	12040	SD12955
U2	1820-0588	2	U: dgtl DM74L20N	12040	SD12981
U3 thru U5	1820-0269	3	U: SN7403N	01295	SN12785
U6	1820-0627	1	U: U7B93L0159X	82170	SL 16900
U7	1820-0586	3	U: dgtl DM74L04N	12040	DM74L04N
U8	1820-0584	1	U: DM74L02N	12040	DM74L02N
U9	1820-0587	3	U: dgtl DM74L10N	12040	SD12953
U10	1820-0583		U: DM74L00 N	12040	SD12955
U11	1820-0588		U: dgtl DM74L20N	12040	SD12981
U12	1820-0587		U: dgtl DM74L10N	12040	SD12953
U13	1820-0656	2	U: dgtl SN74L98N	01295	SN14266
U14	1820-0583		U: DM74L00 N	12040	SD12955
U15	1820-0595	1	U: DM74L73N	12040	DM74L73N
U16	1820-0586		U: dgtl DM74L04N	12040	DM74L04N
U17	1820-0583		U: DM74L00N	12040	SD12955
U18	1820-0589	2	U: dgtl	12040	DM74L30N
U19	1820-0587		U: dgtl DM74L10N	12040	SD12953
U20, U21	1820-0583		U: DM74L00N	12040	SD12955
U22	1820-0949	1	U: selected 1820-0949	-hp-	11144-80001
U23	1820-0946	1	U: CD4001AE	02735	CD4001AE
U24	1820-0589		U: dgtl	12040	DM74L30N
U25, U26	1820-0583		U: DM74L00N	12040	SD12955
U27	1820-0585	2	U: DM74L03N	12040	DM74L03N
U28	1820-0656		U: dgtl SN74L98N	01295	SN14266
U29	1820-0585		U: DM74L03N	12040	DM74L03N
U30	1820-0273	2	U: MC 1806P	04713	SC8166PK
U31	1820-0586		U: DM74L04N	12040	DM74L04N
U32	1820-0273		U: MC 1806P	04713	SC8166PK
J1	1251-3283	1	Conn: rack & panel	02660	57-20240-2
Q1 thru Q14	1854-0071	14	Trans: Si NPN	01295	SKA1124
R1	0757-0283	1	R: fxd flm 2 kΩ ± 1% 1/8 W	14674	C4 T-O obd
R2	0698-4473	1	R: fxd flm 8.06 kΩ ± 1%	14674	C4 T-O obd
R3, R4	1810-0136	2	R: set-film	91637	TKR
R5	1810-0049	1	R: network	56289	200C-1906-CRR
R6	0684-1021	2	R: fxd comp 1000 Ω ± 10% 1/4 W	01121	CB 1021
R7	0684-1041	1	R: fxd comp 100 kΩ ± 10% 1/4 W	01121	CB 1041
R8	0684-1031	1	R: fxd comp 10 kΩ ± 10% 1/4 W	01121	CB 1031
R9 thru R11	0684-6821	3	R: fxd comp 6800 Ω ± 10% 1/4 W	01121	CB 6821
R12	0684-1021		R: fxd comp 1000 Ω ± 10% 1/4 W	01121	CB 1021
R13	0683-3025	1	R: fxd comp 3000 Ω	01121	CB3025
	0380-1036	2	STDR-Stud Mt Hex (6-32 Male/Female)	-hp-	
	1251-2501	24	Conn: sgl cont	00779	50462-8
	1530-1098	2	Fastener, Clevis (6-32)	-hp-	
	5040-5889	1	Plug-end, Plastic	-hp-	
	59405-04101	1	Plate: end cover	-hp-	
	11144-26601	1	Frame: support	-hp-	
	11200-04101	1	Cover: I/O	-hp-	
			10631C Cable (12 foot)		
	1390-0248	4	Screw (6-32)	-hp-	
	0510-0015	4	Retainer-Screw	0018A	1500-12-CD

Table 5-3. Replaceable Parts Cont'd.

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
Δ_A	59405-66503	1	HP-IB Test Card	-hp-	
P1	1251-3284	1	Conn-24 pin, Male	-hp-	
	0380-0517	2	STDF-STUD (riveted on Connector)	-hp-	
J1	1250-0083	1	Conn-RF	24931	28JR-130-1
	2950-0030	1	Nut-Hex	73734	9003
	3050-0067	1	Washer-Flat	73734	31550
	2190-0016	1	Lockwasher	78189	1920-02
R1	0683-1015	1	R:fxd 100 ohm 5% 1/4W	01121	CB1015
R2	0683-2015	1	R:fxd 200 ohm 5% 1/4W	01121	CB2015
	1260-0510	1	16-pin DIP-Dummy	-hp-	
	1390-0248	2	Scr-Cptve (6-32)	-hp-	
	0510-0015	2	Retainer-Screw	0018A	1500-12-CD
	1251-0600	18	Pins-Standoff	-hp-	
Δ_A	5061-0753	4	Assy-Clip Lead	-hp-	

Δ_A Delete for Model 11144A

SECTION VI
CIRCUIT DIAGRAMS

6-1. INTRODUCTION.

6-2. This section contains the 59405A schematic, component location diagrams, a diagram of HP-IB handshake events, and a table of calculator Status Output codes.

SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRIES

3. DENOTES FRAME GROUND.
   USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

4. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

5. DENOTES ASSEMBLY.

6. 7 DENOTES PC CONNECTOR PIN NUMBER.

7. 7 DENOTES HP-IB CONNECTOR PIN NUMBER.

8. 924 DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP, (e.g. 924 = WHITE, RED, YELLOW.)

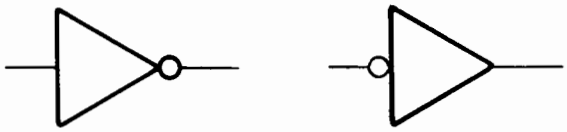
9. EACH GATE IS INDIVIDUALLY DEPICTED BY ITS LOGICALLY EQUIVALENT "OR" OR "AND" SYMBOL ACCORDING TO ITS USE IN THE CIRCUIT. NOTICE THE LOGICAL EQUIVALENCE OF THE "NOR" GATE AND THE "AND" GATE WITH INVERTED INPUTS, AND OF THE "NAND" GATE AND THE "OR" GATE WITH INVERTED INPUTS.

10. SIGNAL NAMES ON THE SCHEMATICS HAVE AN L OR H PREFIX TO INDICATE A LOW OR HIGH RESPECTIVE "TRUE" LEVEL.

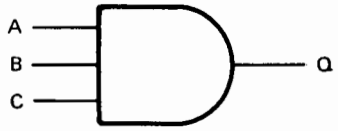
11. "LOW" LEVEL = 0 V dc TO 0.4 V dc;
    "HIGH" LEVEL = + 2.4 V dc TO + 5 V dc.

12. U3, U4, U5, U27 AND U29 HAVE OPEN COLLECTOR OUTPUTS.

13. THE PERIPHERAL SELECT CODE FOR THE 59405A IS 13. THIS CORRESPONDS TO 1-0-1-1 AT A1 PINS 18, V, 19 AND W RESPECTIVELY.

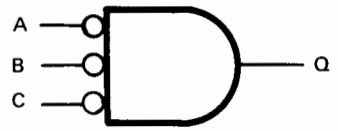


DENOTES INVERTER



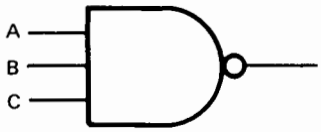
A	B	C	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

DENOTES "AND" GATE



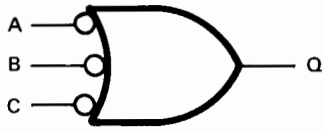
A	B	C	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

DENOTES "AND" GATE WITH INVERTED INPUTS



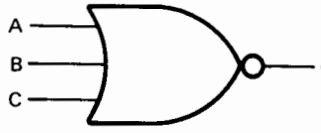
A	B	C	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

DENOTES "NAND" GATE: "AND" WITH INVERTED OUTPUT.



A	B	C	Q
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

DENOTES "OR" GATE WITH INVERTED INPUTS.



A	B	C	Q
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

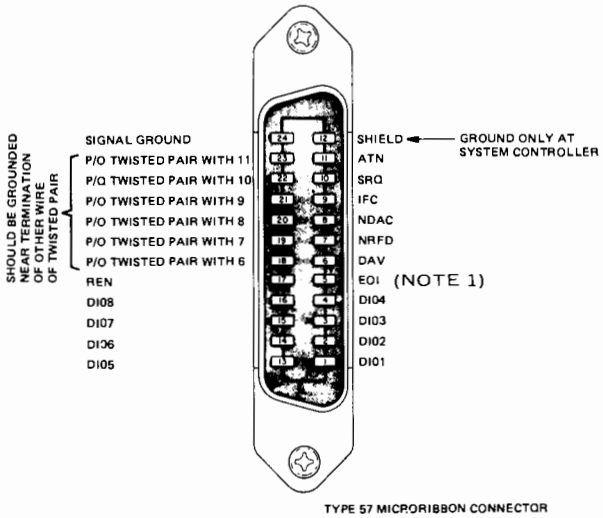
DENOTES "NOR" GATE: "OR" WITH INVERTED OUTPUT.

59405A TO CALCULATOR INTERFACE

Component Side						Circuit Side
	Key				Key	
1	Ground		Ground	A		
2	+5 V		+5 V	B		
3				C		
4				D		
5				E		
6	(L)DI Ø	Data Input bit Ø	Data Output bit Ø	(H)DO Ø	F	
7	(H)DO 1	Data Output bit 1	Data Output bit 2	(H)DO 2	H	
8	(L)DI 3	Data Input bit 3	Data Output bit 3	(H)DO 3	J	
9	(L)DI 2	Data Input bit 2	Data Input bit 1	(L)DI 1	K	
10	(H)DO 4	Data Output bit 4	Data Input bit 4	(L)DI 4	L	
11	(H)DO 5	Data Output bit 5	Data Input bit 5	(L)DI 5	M	
12	(H)DO 6	Data Output bit 6	Data Input bit 6	(L)DI 6	N	
13	(H)DO 7	Data Output bit 7	Data Input bit 7	(L)DI 7	P	
14	(H)SO Ø	Status Output bit Ø	Status Input bit Ø	(L)SI Ø	R	
15	(H)SO 1	Status Output bit 1	Status Input bit 1	(L)SI 1	S	
16	(H)SO 2	Status Output bit 2			T	
17	(H)SO 3	Status Output bit 3			U	
18	(H)CO Ø	Select Code bit Ø	Select Code bit 1	(H)CO 1	V	
19	(H)CO 2	Select Code bit 2	Select Code bit 3	(H)CO 3	W	
20					X	
21	(L)CEO	Device Ready			Y	
22	Ground		Stop	(L)STP	Z	

11144A - B - 3151

59405A TO HP-IB INTERFACE



NOTE 1. The 59405A and 11144A are unable to control the EOI Line.

Figure 6-1. 59405A Connectors.

Table 6-1. 9820A/21A Status Output.

Statements	Result	Status Output		
		SO2	SO1	SOØ
0: FMT Y1,Z; WRT 13	ATN line low (Command mode)	0	0	1
0: FMT Y2,Z; WRT 13	ATN line high (Data mode)	0	1	0
0: FMT Y3,Z; WRT 13	REN line low (Remote mode)	0	1	1
0: FMT Y4,Z; WRT 13	REN line high (Local mode)	1	0	0
0: FMT Y5,Z; WRT 13	Control flag true (Controller mode)	1	0	1
0: FMT Y6,Z; WRT 13	Control flag false (Non-controller mode)	1	1	0

Table 6-2. 9830A Status Output.

Statements	Result	Status Output		
		SO2	SO1	SOØ
10: FORMAT B				
20: OUTPUT (13,10)256;	ATN line low (Command mode)	0	0	1
20: OUTPUT (13,10)512;	ATN line high (Data mode)	0	1	0
20: OUTPUT (13,10)768;	REN line low (Remote mode)	0	1	1
20: OUTPUT (13,10)1024;	REN line high (Local mode)	1	0	0
20: OUTPUT (13,10)1280;	Control flag true (Controller mode)	1	0	1
20: OUTPUT (13,10)1536;	Control flag false (Non-controller mode)	1	1	0

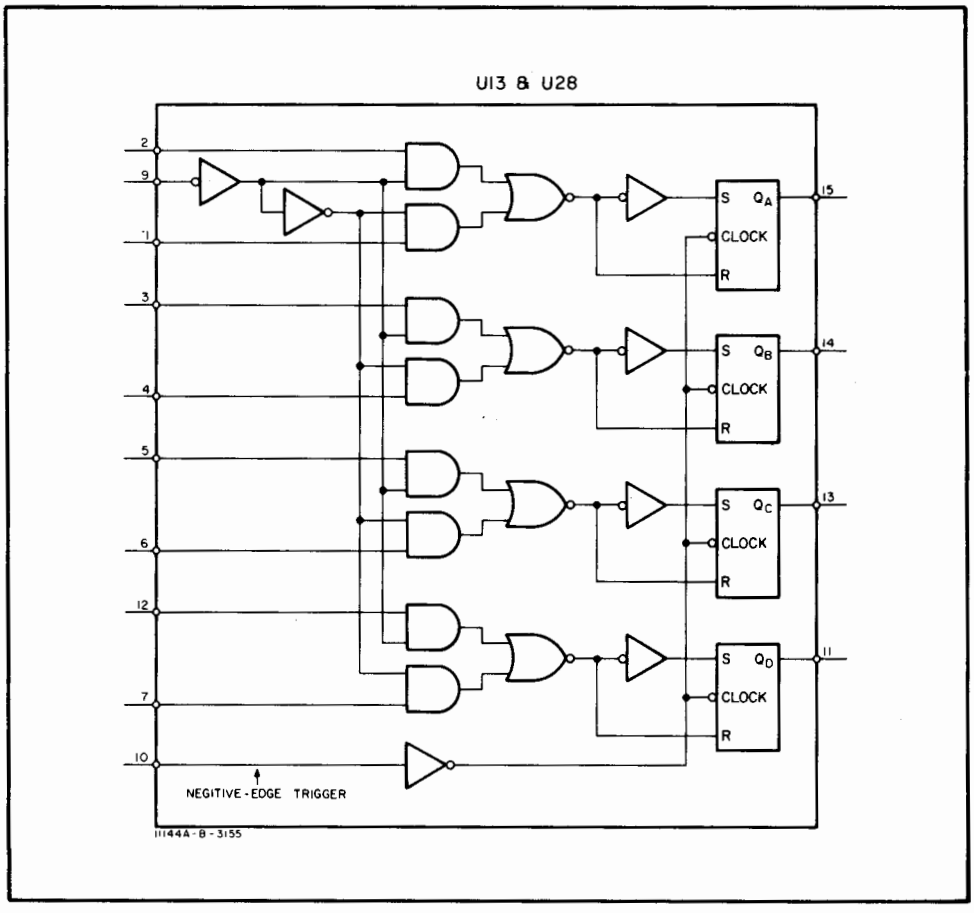
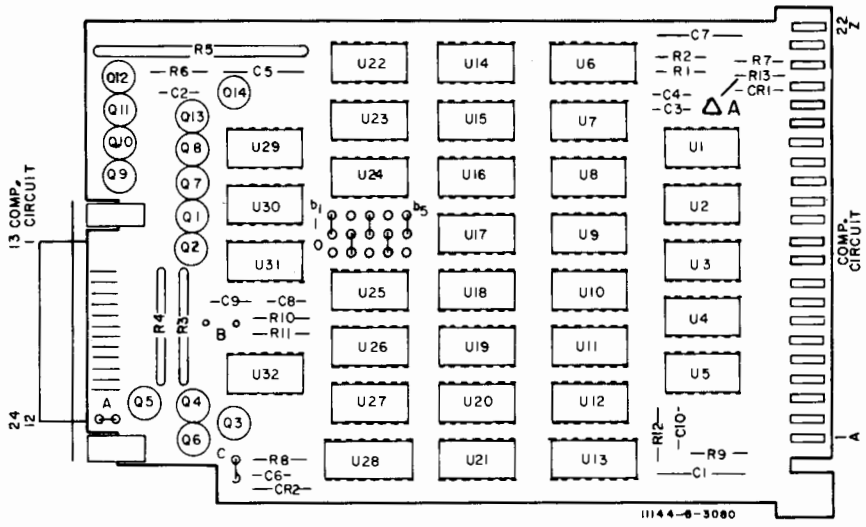


Figure 6-2. U13 and U28.



A1
hp Part No. 11144-66501
Rev B

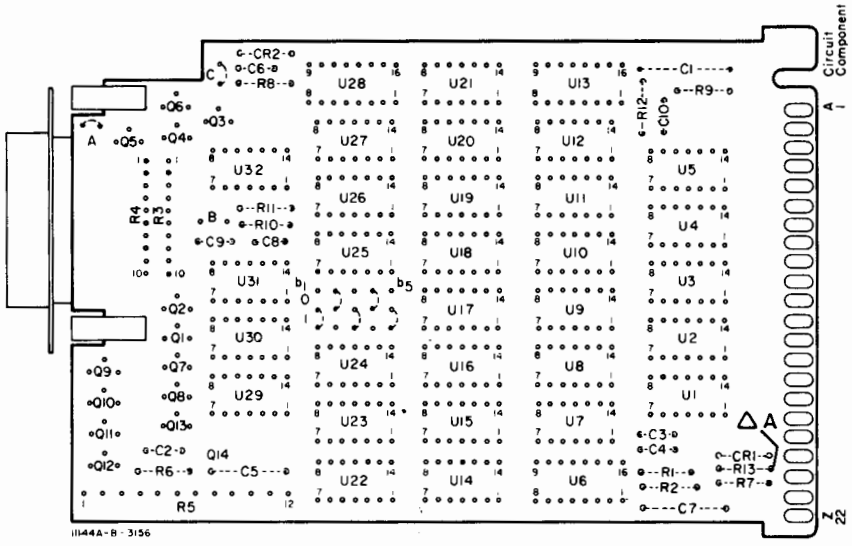
Δ BACKDATING NOTES:

Δ_A FOR MODEL 11144A, DELETE R13.

Δ_B FOR MODEL 11144A, INTERCHANGE U14 (1, 2, 3 SECTION) AND U22 (13, 12, 11 SECTION).

Δ_C FOR MODEL 11144A, MAKE THE FOLLOWING CHANGES.

CHANGE	*TO*
(L)NRFD	*(H)RFD*
(L)NDAC	*(H)DAC*
(L)ATN	*(L)MRE*
(L)IFC	*(L)EOP*



A1
hp Part No. 11144-66501
Circuit Side

NOTE

THE 59405A AND 11144A ARE UNABLE TO CONTROL THE **EOI** *(END OR IDENTIFY) LINE.*

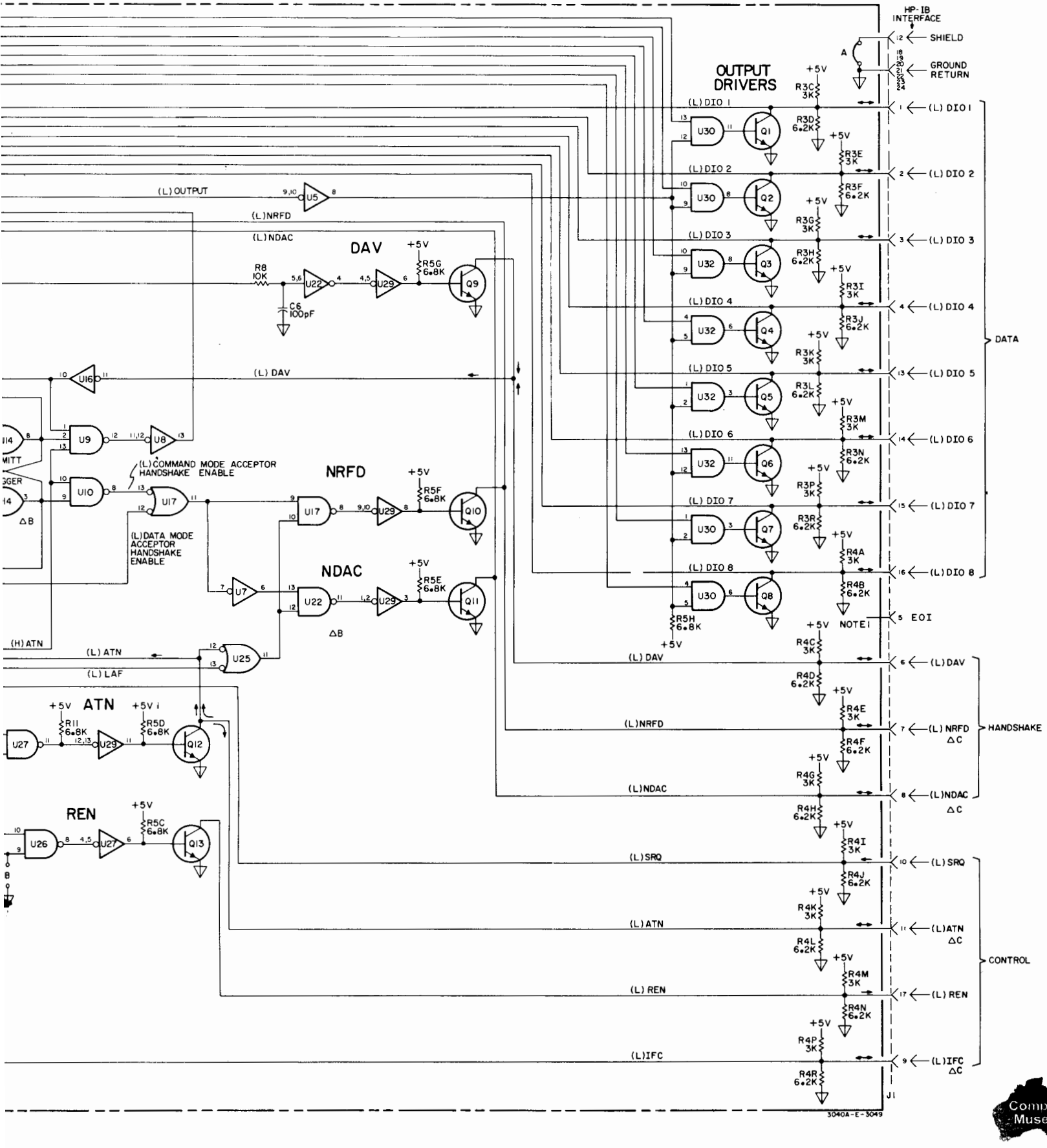
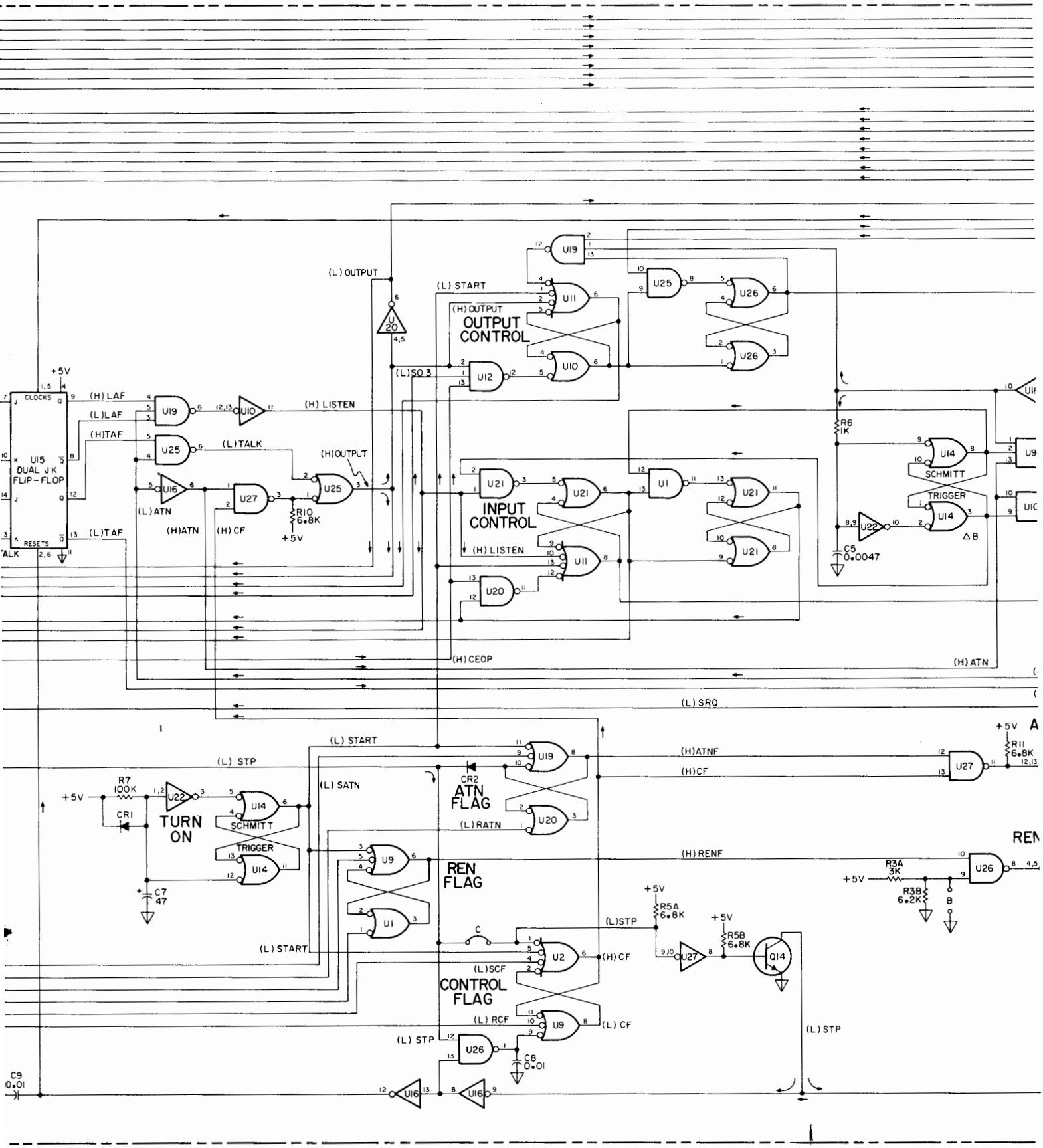
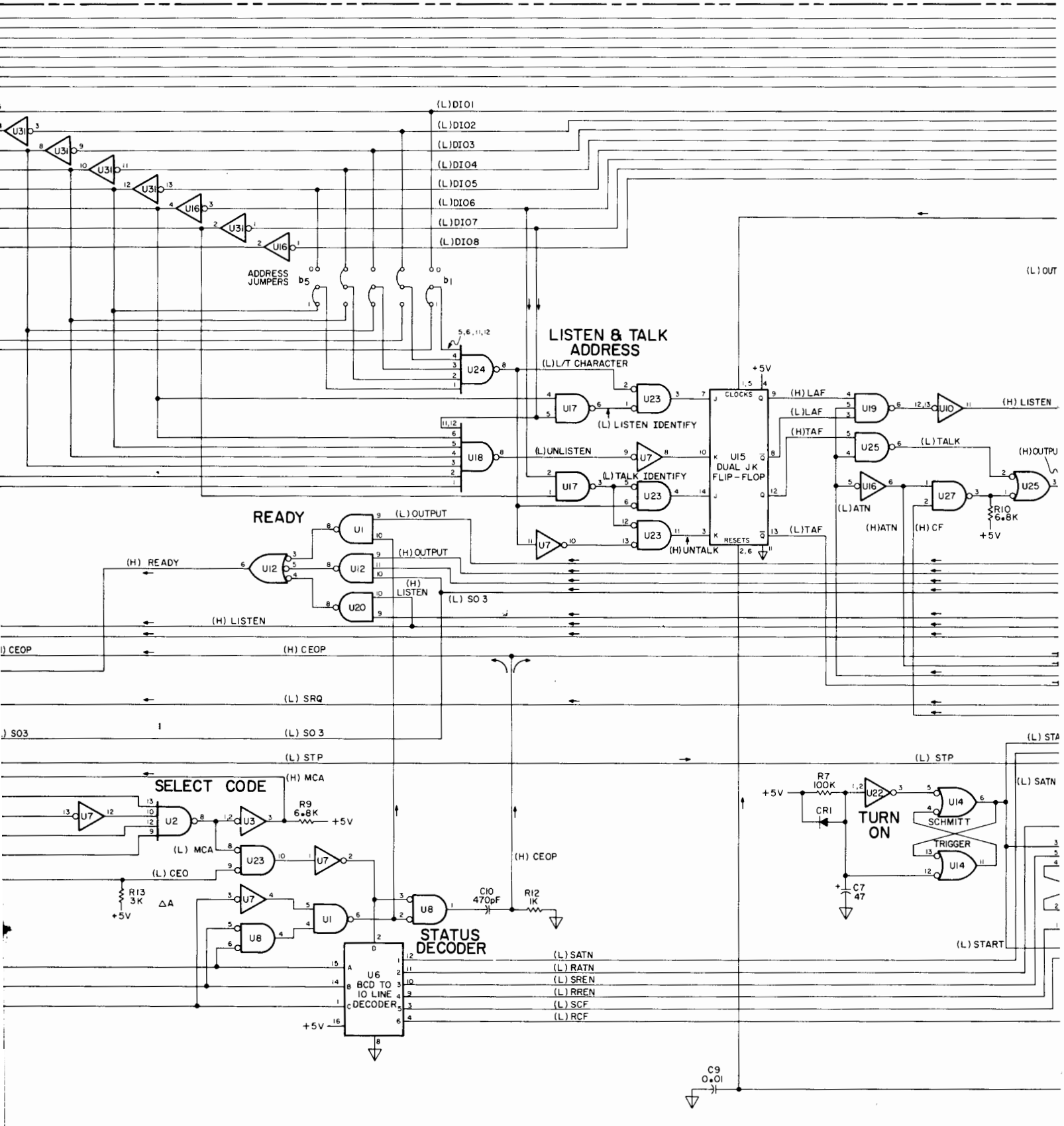
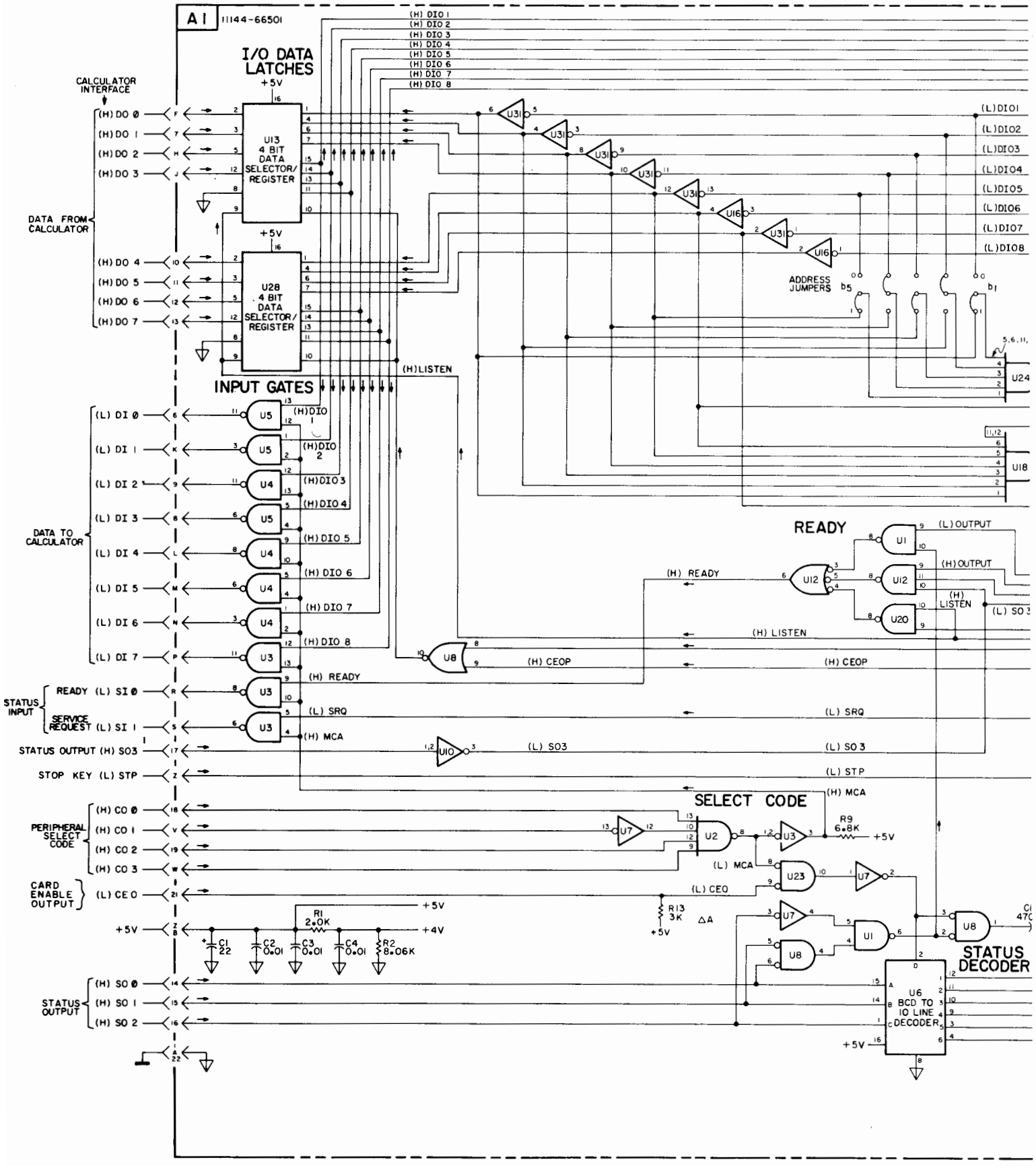


Figure 6-3. Schematic and Component Location.


(L) OUTPUT
(L) START
(H) OUTPUT
OUTPUT CONTROL
(L) SQ 3
U19
U11
U10
U12
U25
U26
U20
+5V
U15 DUAL J K FLIP-FLOP
CLOCKS
RESETS
(H) LAF
(L) LAF
(H) TAF
(L) TAF
(L) TALK
(H) LISTEN
U16
U27
U25
R10 6.8K
(L) ATN
(H) ATN
(H) CF
INPUT CONTROL
U21
U1
(H) CEOP
(H) ATN
R6 1K
U14
SCHMITT TRIGGER
U22
C5 0.0047
ΔB
(L) SRQ
(L) STP
(L) START
R7 100K
CR1
TURN ON
C7 47
(L) SATN
CR2
ATN FLAG
(H) ATNF
(H) CF
R11 6.8K
U27
(L) RATN
U20
U9
REN FLAG
(H) RENF
R3A 3K
R3B 6.2K
B
U26
C
U2
(L) SCF
CONTROL FLAG
(L) RCF
(L) CF
(L) STP
R5A 6.8K
R5B 6.8K
Q14
C8 0.01
C9 0.01
U16


(L)DIO1
(L)DIO2
(L)DIO3
(L)DIO4
(L)DIO5
(L)DIO6
(L)DIO7
(L)DIO8
ADDRESS JUMPERS
b5
b1
LISTEN & TALK ADDRESS
(L)L/T CHARACTER
(L) LISTEN IDENTIFY
(L)UNLISTEN
(L) TALK IDENTIFY
(H) UNTALK
U15 DUAL J-K FLIP-FLOP
CLOCKS
RESETS
(H) LAF
(L)LAF
(H)TAF
(L)TAF
(H) LISTEN
(L)TALK
(H)OUTPU
(L)ATN
(H)ATN
(H) CF
R10 6.8K
+5V
READY
(L) OUTPUT
(H) OUTPUT
(H) READY
(H) LISTEN
(L) SO 3
(H) CEOP
(L) SRQ
(L) STP
SELECT CODE
(H) MCA
(L) MCA
(L) CEO
R9 6.8K
R13 3K
ΔA
C10 470pF
R12 1K
STATUS DECODER
U6 BCD TO 10 LINE DECODER
(L) SATN
(L) RATN
(L) SREN
(L) RREN
(L) SCF
(L) RCF
R7 100K
CR1
TURN ON
SCHMITT TRIGGER
C7 47
(L) START
C9 0.01


A1 11144-66501
I/O DATA LATCHES
+5V
CALCULATOR INTERFACE
(H) DO Ø
(H) DO 1
(H) DO 2
(H) DO 3
(H) DO 4
(H) DO 5
(H) DO 6
(H) DO 7
DATA FROM CALCULATOR
U13 4 BIT DATA SELECTOR/ REGISTER
U28 4 BIT DATA SELECTOR/ REGISTER
(H) DIO 1
(H) DIO 2
(H) DIO 3
(H) DIO 4
(H) DIO 5
(H) DIO 6
(H) DIO 7
(H) DIO 8
(L) DIO1
(L) DIO2
(L) DIO3
(L) DIO4
(L) DIO5
(L) DIO6
(L) DIO7
(L) DIO8
ADDRESS JUMPERS
(H) LISTEN
INPUT GATES
(L) DI Ø
(L) DI 1
(L) DI 2
(L) DI 3
(L) DI 4
(L) DI 5
(L) DI 6
(L) DI 7
DATA TO CALCULATOR
READY
(L) OUTPUT
(H) OUTPUT
(H) READY
(H) LISTEN
(L) SO 3
(H) CEOP
(L) SRQ
(H) MCA
STATUS INPUT
READY (L) SI Ø
SERVICE REQUEST (L) SI 1
STATUS OUTPUT (H) SO3
STOP KEY (L) STP
SELECT CODE
PERIPHERAL SELECT CODE
(H) CO Ø
(H) CO 1
(H) CO 2
(H) CO 3
CARD ENABLE OUTPUT
(L) CE O
(L) MCA
(L) CEO
R9 6.8K
R13 3K
ΔA
R1 2.0K
C1 22
C2 0.01
C3 0.01
C4 0.01
R2 8.06K
+4V
STATUS OUTPUT
(H) SO Ø
(H) SO 1
(H) SO 2
STATUS DECODER
U6 BCD TO 10 LINE DECODER