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OPERATORS GUIDE

MODEL 1610A

LOGIC STATE ANALYZER

Manual Part Number 0161 o-90903
Microfiche Part Number 0161 o-90803

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SAFETY SUMMARY

*The following general **safety** precautions must be observed during all phases of operation, service, and repair of this instrument. Failure **to** comply with these precautions or with specific warnings elsewhere in this manual vioiafes safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no i/ability **for** the customer's failure to comply with these requirements.*

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground The instrument is equipped with a three-conductor ac power cable. The power cable rnust either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet, The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed To avoid Injuries, always disconnect power and discharge circuits before touching them

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.

Breakage of the Cathode-ray Tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT Implosion, avoid rough handling or jarring of the instrument. Handling of the CRT shall be done only by qualified maintenance personnel using approved safety mask and gloves.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS.

Warnings such as the example below, precede potentially dangerous procedures throughout this manual Instructions contained in the warnings must be followed

WARNING

Dangerous voltages, capable of causing death, are present in this instrument.
Use ex'treme caution when handling, testing, and adjusting.

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PREFACE

------- *HOW TO USE THIS BOOK* -------

How you use this book is largely a matter of your experience with Logic State Analyzers.

An experienced Logic State Analyzer operator can begin using the Hewlett-Packard 1610A after getting acquainted with it in Chapter I and II.

If this IS your first opportunity to use a Logic State Analyzer, go through the book page by page so you thoroughly understand your instrument and how it works.

You may want to try something you're not sure of, or that is not described in the book. TRY IT! You won't damage the 161 OA. If what you try is not acceptable to the instrument, it will tell you why on the display.

------- *WHEN TO USE THIS BOOK* -------

Whatever your experience level, use selected portions of the book the first time you operate your 161 OA.

Study the material presented here whenever you have a few minutes. Some of the machine capabilities are rather subtle; thorough understanding of them will put you in a position of being ready when that new, complex measurement problem presents itself.

Chapter I

INTRODUCTION TO YOUR HP MODEL 1610A LOGIC STATE ANALYZER

------- GENERAL -------

Your Hewlett-Packard Model 1610A Logic State Analyzer (called simply 1610A in this book) is a general-purpose instrument which extends measurement capabilities in the Data Domain beyond the capabilities of any previous machine.

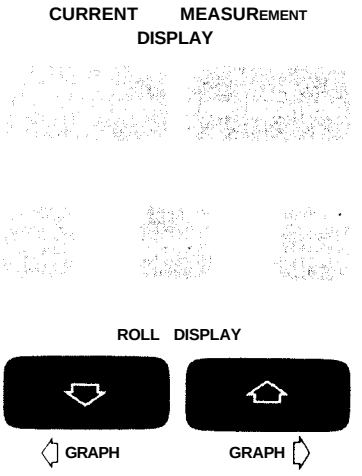
Analysis of the most advanced state machines, and the most complex software, is possible using the 161 OA. Yet Operating simplicity has been achieved by user-oriented engineering design; the 161 OA performs many routine "house-keeping" chores that the operator used to do.

As you go through this book, you may find some unfamiliar terms generated by the unique characteristics of the 161 OA. A glossary of these terms is included in the back of the book as Appendix A.

-------THE KEYBOARD -------

The 1610A keyboard contains 39 keys divided into four functional groups. A fold-out illustration of the keyboard is at the back of this book for easy reference as you work.

Current Measurement Display Group:



Calls up a display menu which allows you to select clock slope, logic polarity, and number base parameters. Also permits formatting 32 input channels into labelled groups (see **FORMAT MENU, Chapter III).**

Calls up a display menu in which you specify state and count measurements **(see TRACE SPECIFICATION MENU, Chapter III).**

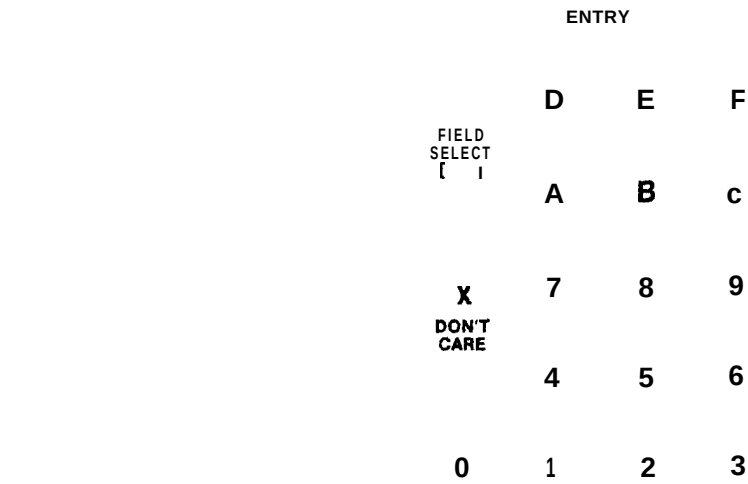
Calls up display menu in which current measurement and count data are displayed **(see TRACE LIST MENU, Chapter III).**

Calls up graphed display of current measurement data for any specified label (see **GRAPH MENU, Chapter III).**

Calls up display menu in which current measurement data is EXCLUSIVE OR'ed with valid stored data; also selection of COMPARED TRACE mode **(see COMPARED TRACE MENU, Chapter III).**

Rolls trace display in the indicated direction to view all 64 memory states. The 20 states displayed are represented by intensified dots in GRAPH MENU. Intensified dots on the graph shift left or right as the trace is rolled,

Entry Group:



0 — 9

or

A - F

Alphanumeric keys for entering information into all entry fields on the displays.

FIELD SELECT [ ]

Permits selection among field content variables. This key is used to change inverse fields which contain brackets ([ ]).

X DON'T CARE

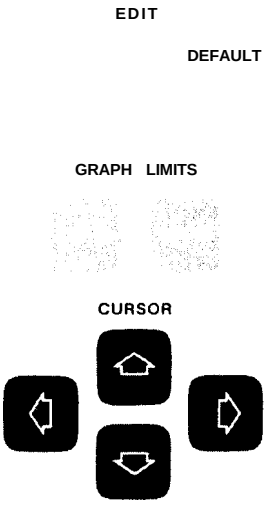
In entry fields:

"X" indicates that all allowed digit values are acceptable. In octal fields allowed values of "X" are 0 through 7 (3 bits). In hexadecimal fields allowed values for "X" are 0 through F (4 bits).

In label assignment fields:

"X" indicates that the channel is not used. An used channel is not included in any other label reference.

Edit Group:



EDIT

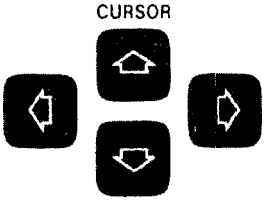
Insert or delete lines which allow further definition of trace location in program flow; or which selectively "TRACE ONLY STATES" which meet any of several conditions.

DEFAULT

Returns the currently displayed menu to its simplest form.

GRAPH LIMITS

Used in TRACE GRAPH MENU only. Automatically changes upper or lower graph limit.



Used to move blinking cursor in indicated direction.

Execute Group:

Transfers current measurement data (with FORMAT and TRACE SPECIFICATIONS) into separate storage memory; does NOT alter current measurement information.

Performs an exchange between current measurement data and data in stored memory (see **COMPARED TRACE, Chapter III).**

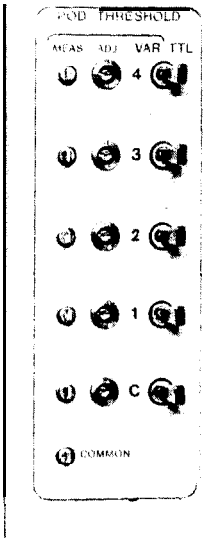
Initiates a print-out of the current display (except GRAPH) on an interfaced HP Model 9866A/B Printer.

TRACE

Initiates a search in data flow to find and trace data that corresponds to the parameters defined in the specification menus then displays resultant data. Pressing the key one time initiates a single trace; holding the key down places the 161 OA in the CONTINUOUS TRACE mode, permitting observation of dynamic program flow.

Stops any “CONTINUOUSTRACE,““COMPAREDTRACE,””TRACE,” or “PRINT” which remains “IN PROCESS.”

Probe Threshold: ***------- THE FRONT PANEL -------***



MEAS: A point of attachment for a voltage measuring device when adjusting threshold level.

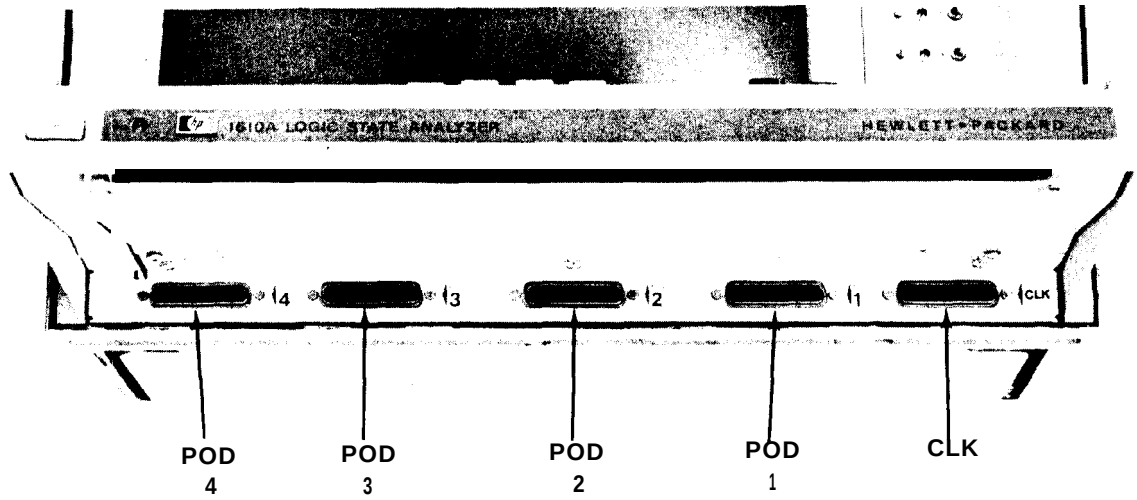
ADJ: Adjustment for setting threshold level to the desired amplitude in a range of -10 V to +10 V.

VAR/TTL: When this switch is set to TTL, the corresponding probe pod is set to operate at TTL (1 .4 V) threshold levels. In the VAR position, the probe pod is adjusted to required voltage at MEAS point.

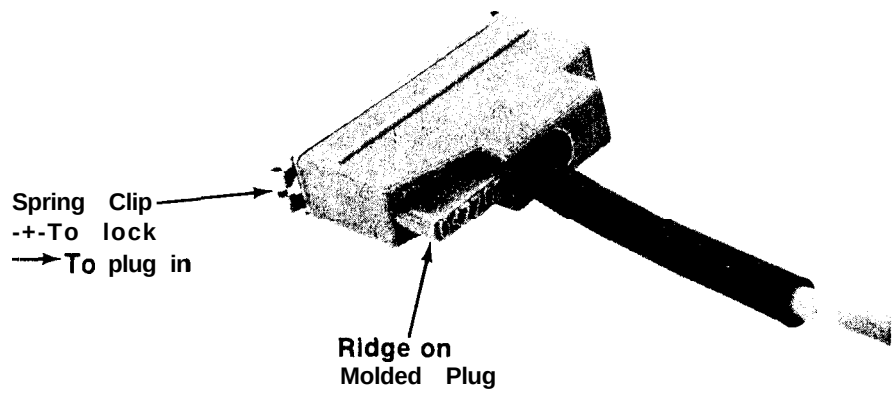
COMMON: A grounding point for measuring threshold voltage levels for any probe pod.

------- PROBE POD CABLE CONNECTORS -------

Directly under the keyboard are sockets for connecting the probe pod cables. These cables are not numbered and will operate interchangeably, except for the Clock pod. Pod numbers in the photograph relate pod location to the FORMAT SPECIFICATION



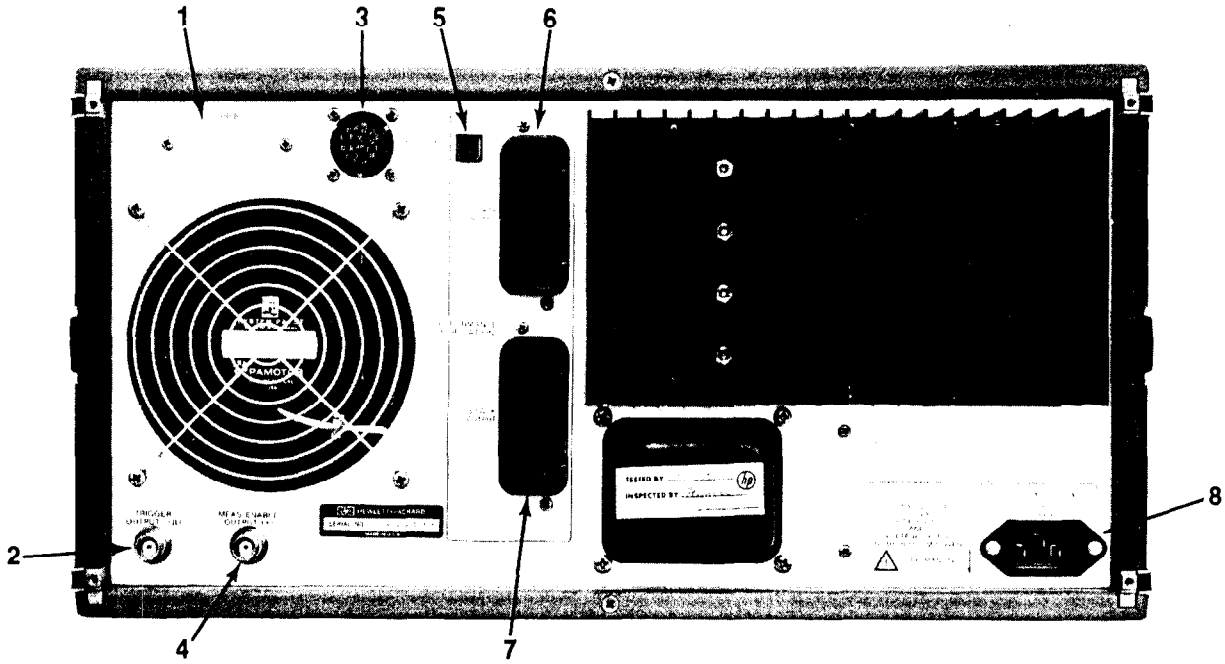
menu display **(see Chapter** III). Each connector is keyed to the socket; the ridge in the molded plug should be on the left when being inserted in the socket. A spring clip on the connector locks it in position when it is pushed to the left as shown.



To insert plug into socket, slide spring clip to the right, insert plug in socket, slide spring clip to the left to lock in position,

There are eight data lines and a ground lead in each pod. These lines are identified by wire colors, The white/black line represents data bit 0, the white/brown line represents data bit 1, and so on to the white/violet line which represents data bit 7, following the standard resistor value color code. A black lead indicates “ground.” For purposes of the FORMAT SPECIFICATION menu **(Chapter III),** line 0 represents the least significant bit and line 7 represents the most significant bit.

..... THE REAR PANEL -s---m-



1. For installation of a future Option which will permit use of the 161 OA with the HP Interface Bus (HP IB).

2. TRIGGER OUT ⎍⎍ connector provides high repetition rate pulses useful for triggering external instrumentation such as oscilloscopes. Pulse output begins when the TRACE key is pressed, and a 50 ns pulse is generated each time the trace specification is satisfied. If the trace position includes a state squence, the pulse occurs when the last valid state is found; pulse output continues until a new specification is traced, or until the [redacted] key is pressed.

3. PRINTER connector permits interfacing the 161 OA with an HP Model 9866A/B Printer for obtaining hard copy of all display menus except GRAPH.

4. MEAS ENABLE provides a low logic level when the 161 OA begins trace execution; level remains low until the trace state is recognized or until [redacted] key is pressed.

5. START pushbutton initiates internal performance verification routines. Performance verification destroys current specifications and data.

6. DATA POD connected to this socket provides a continuous 8-bit count at 10 MHz rate; also tests the data pod for accurate operation during performance verification.

7. CLOCK POD connected to this socket uses internally generated 10 MHz clock signal for performance verification routines.

8. Line power socket.

------- *BASIC INFORMATION ABOUT MENU DISPLAYS* -------

Some features are common to all menu displays. These features are described here so you will recognize them in the following pages.

1. Menu Title and Machine Status.

The first line of all menus gives the name of the menu on the left. Machine status is on the right and indicates the last machine operation initiated and whether the operation is COMPLETED, FAILED, ABORTED, or IN PROCESS. When the 161 OA is in continuous or compared trace modes, status condition will continue to flash these possible conditions.

2. ERROR, WARNING, and Information Messages.

Model 1610A is a conversational machine. Line two of each menu is reserved for communication between the 161 OA and the operator. Some of the messages, ERROR and WARNING, imply a sense of urgency, but they do not in any way mean damage to the machine or injury to the operator. ERROR is only to alert the operator that he should make an immediate correction. WARNING cautions the operator that a current entry may lead to an ERROR, or that a limit of execution has been reached. Appendix B lists and describes these messages in more detail.

3. Multiple-Choice Fields.

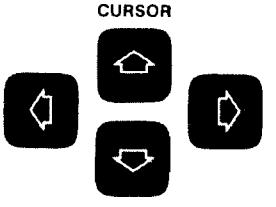
An inverse video field which contains brackets ([ ]) indicates that you have a choice among two or more variables in defining the parameter for that particular field. Your choice is made by pressing the FIELD SELECT [ ] key until the proper field content is displayed. The 161 OA remembers the choice you made and carries it into all other menu displays where it applies.

IMPORTANT: If the COMPARED TRACE MODE selectable field is left in [STOP=] or [STOP≠], condition, it must be returned to [OFF] to restore single or continuous trace operation in any menu.

4. Entry Fields.

Inverse video fields without brackets indicate areas where you enter alphanumeric characters which define labels, states of interest, or state occurrences

5. The Cursor.

A blinking inverse field one character wide, called the Cursor, indicates the field in which a selection may be made, or the location where the next alphanumeric character will be entered. You may reposition the cursor into the desired field by using the 

keys in the EDIT section of the keyboard. The cursor is removed when the 161 OA is operating in any continuous mode.

6. Menu Display Sections.

Each section of the menu display is given a title describing the data parameter which it controls. Section titles are positioned along the left margin of the display.

Chapter II

OPERATING YOUR 1610A

------- *PREPARING FOR OPERATION* -------

Naturally, you want to get your 161 OA “on the air” as soon as you can. This chapter will help you accomplish this. Let’s get started!

1. Connect the Data Pods and the Clock Pod cables under the keyboard as described in Chapter I.

CAUTION

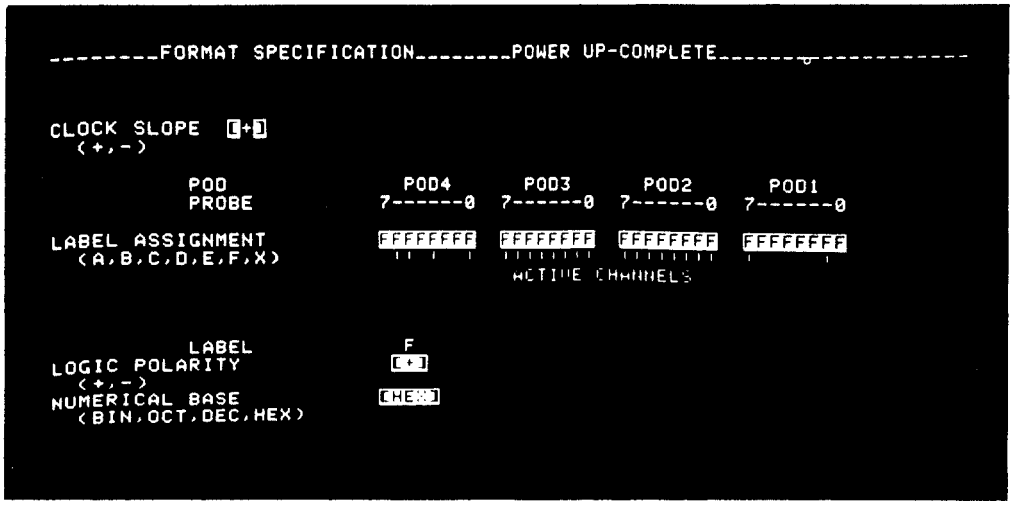
‘Your 1610A can be damaged if you operate it from a voltage source different than that for which the internal Voltage Selector switches are set. These switches are set at the factory for operation on 110-120 Vac. If your primary power source is different, have qualified service personnel change the Voltage Selector switches to agree. Probe input limit ±15 V peak.

2. Plug the 1610A into the primary power source and set the front-rail LINE switch **(see keyboard fold-out)** to the ON position. The power indicator light will come on if power is present and an audible signal will indicate that the 1610A is in a power-up condition. If you wish to do a Performance Verification procedure, see Chapter V.

3. In a few seconds, a display will appear on the CRT and you are ready to start operation.

------- A QUICK RUN-THROUGH PROCEDURE -------

1. The display immediately seen on power-up is shown below. The first line shows that this is the FORMAT SPECIFICATION menu, and the machine status shows that the last operation initiated, Power-up, is complete.

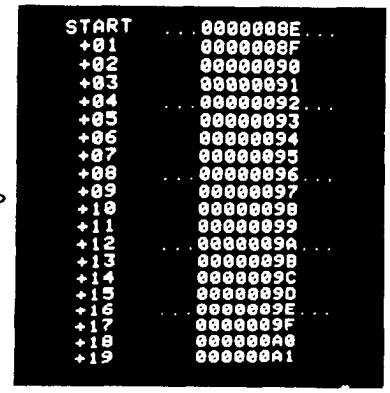


2. Line two shows a WARNING signal alerting you to a SLOW CLOCK condition. This message is a good indicator during operation that a clock probe has come loose, or that the system under test is malfunctioning. See Chapter III for a detailed discussion of the FORMAT SPECIFICATION menu.

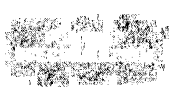
3. Connect probe pod 1 and the clock probe pod to their respective sockets in the PERFORMANCE VERIFICATION section on the rear panel. These ports provide a continuous 8-bit count at a 10 MHz rate. Notice that when this is done, the SLOW CLOCK message disappears.

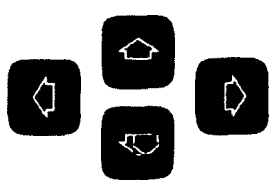
4. Press the TRACE key in the EXECUTE section of the keyboard. Notice that the 161 0A automatically goes to the TRACE LIST menu, and the machine status reminds you that the last operation you initiated was TRACE, and the operation is COMPLETE:.

5. The resulting trace consists of eight hexadecimal digits representing 32 bits of data. Six of the digits are constant (data pods not connected) and two bits are counting from 00_{16} to FF_{16}. Trace starting point is also indicated. Each successive line of memory is numbered with a positive decimal integer for ease of reading. The "+" sign indicates that the state follows the trace state in positive time.



6. Press and hold  in CURRENT MEASUREMENT DISPLAY section of the keyboard. The display moves up enabling you to view any part of the 64-state memory. When the end of memory is reached, an audible signal will sound, and a WARNING-COMMAND IGNORED message alerts you that an operating limit has been reached; the display will roll no further. Release the ROLL DISPLAY key and the message will disappear.

7 Press  in CURRENT MEASUREMENT DISPLAY section of the keyboard. The format specification menu reappears and allows you to define state parameters for a more useful display. See Chapter III for detailed discussion of FORMAT SPECIFICATION menu.

8 Use  (CURSOR) keys in the EDIT section of the keyboard to move the blinking cursor (now located at 

) to 

fields.

9 Use the X / DON'T CARE key in ENTRY section of the keyboard to enter "X" in all bit positions in Pod 2, Pod 3, and Pod 4 columns. Holding the key down causes the "X" to be entered continuously in each field.

10. Move the cursor to the selectable NUMERICAL BASE [HEX] · BIN · OCT · DEC · HEX · field. Press FIELD SELECT [ ] repeatedly until the field contains [OCT] number base.

1 1. Press key. The TRACE SPECIFICATION menu allows you to control trace and count measurements. See Chapter III for a detailed discussion of this menu.

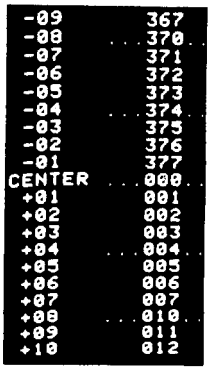
12. The cursor is in [START] TRACE . Press FIELD SELECT [ ] repeatedly until field reads [CENTER] TRACE .

13. Move cursor to open field in label F column and enter 0008. Now you have specified that state 000_8 is to be centered in the trace.

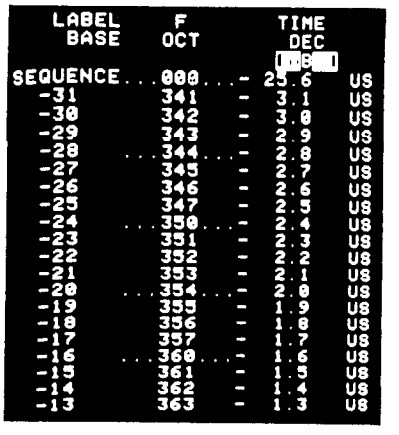
14. Press key in the EDIT section of the keyboard. Another line is now available for further definition of trace position. Enter 000_8 in the added open field FIND IN SEQUENCE 000 00001 [CENTER] TRACE 008 00001 . With these few keystrokes, you have told the 1610A: "Recognize state 000_8 the first time it appears after trace execution is requested. When state 000_8 is recognized again, initiate a trace in which this second occurrence is centered." But that's not all.

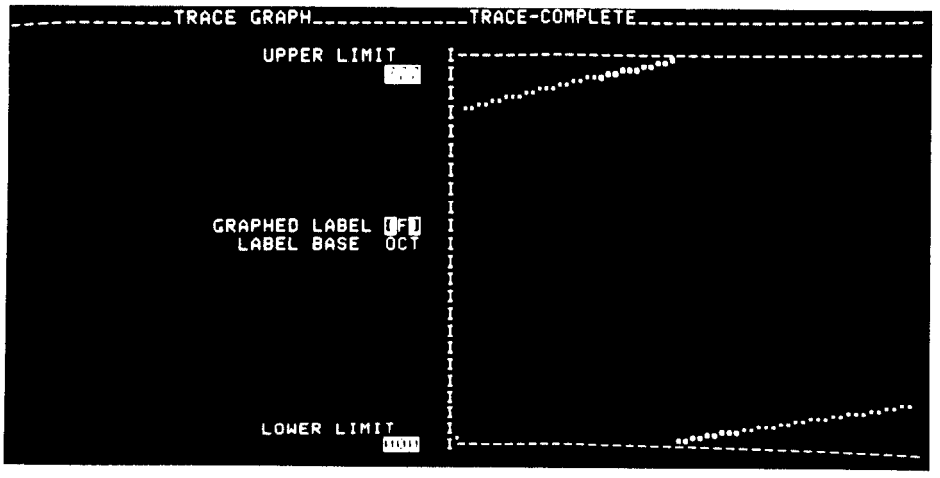
15. Move the cursor to the COUNT [OFF] selectable field and press FIELD SELEC [ ] until the field reads COUNT [TIME] Now you have further specified that when the trace is initiated, the 1610A is to count elapsed time for completion of the 8-bit count cycle from 0008 to 0008.

16. Press the TRACE key. The TRACE LIST menu display (see Chapter III for a detailed description) now shows the second occurrence of 0008 centered in the trace. Data leading up to this state are designated by negative line numbers, and data following this state have positive numbers (negative and positive time, respectively).



17. Press ROLL DISPLAY ⇩ until beginning of the trace is displayed. The display shows the first occurrence of 0008 as SEQUENCE. The TIME (in decimal ABSolute time) reads -25.6 microseconds. Since absolute times are measured from the trace state, it is clear that the elapsed time from first recognition to second recognition is 25.6 μs.





18. Press in CURRENT MEASUREMENT DISPLAY section of the keyboard.

The resulting display shows all 64 states in memory. The first state in the trace is at the extreme left and the last state (state 64) is at the extreme right. Vertical position is determined by state value with respect to the UPPER LIMIT and LOWER LIMIT values. Inl:ensified dots indicate the portion of the current valid data displayed when key is pressed. Press ROLL DISPLAY and observe intensified dots shift to the right

------- *NOW WHA T?* -------

This procedure does not demonstrate all the features of your 161 OA, but it gives you a good idea of operating methods, You begin to recognize the inter-relationships between the keybaord and the displays, or between one display and another. Maybe this all you need to start making meaningful measurements in your system. But if you need more detailed information, Chapter III will give it to you.

Chapter III

DETAILED MENU DESCRIPTIONS

------- *INTRODUCTION* -------

This chapter is intended to help you in two ways:

A quick reminder of the purpose
and content of each menu;
and
A detailed description of each
menu to help solve complex
measurement problems.

To do this, each menu is given a separate fold-out page. A summary of menu capabilities appears first before the page is unfolded. You can glance through these summaries until you find the menu with the capability you need.

When you have located the menu that seems to have what you need, unfold the page for detailed study. Many illustrations are included to help relate the descriptions to what you see on the display.

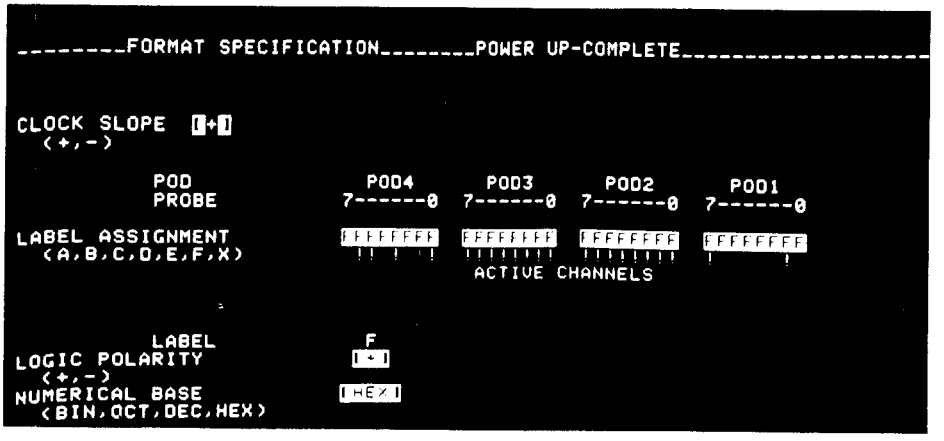
FORMAT SPECIFICATION

MENU

- Permits selection of desired Clock Slope.
- Permits assignment of any of six labels to groups of input lines regardless of Pod boundaries Unused channels may be turned off.
- Indicates presence or absence of activity on each input channel.
- Permits selection of logic polarity to be used in each label group.
- Permits selection of numerical base to be used in each label group.

Details Inside Fold

THE FORMAT SPECIFICATION MENU



Headings aligned with the left margin separate the display into sections indicating the signal parameters controlled by each section; for example, “CLOCK SLOPE”.

Any inverse field containing brackets ([ ]) indicates that the operator may select from variable field contents.

Parentheses enclose field content choices available to the operator.

When the blinking cursor is in this field (or any variable field), pressing FIELD SELECT [ ] changes the field variable

Column headings are a fixed part of the display and permit quick identification of each channel in the label assignment groups.

Entry fields in each pod column allow entry of label designations.

Parentheses enclose labels available for selection by the operator.

Label “X” X DON'T CARE turns off channels to which it is assigned.

One label may be assigned to any number of continuous adjacent channels regard-

less of Pod boundaries; e.g., 

Labels assigned to non-continuous channels are not allowed.

These are called SPLIT LABELS; e.g., 

In case of a split label, WARNING-SPLIT LABEL appears on line 2 of the display, and an audible signal alerts the operator. The cursor is locked into the label assignment field until the split label condition is corrected. No EXECUTE command can be initiated while a split label condition exists.

The symbol "!" indicates channel activity at probe line inputs. Inputs are sampled at a 1 ms rate, and each bit that has changed states in 100 samples will be marked with "!".

Each label assigned in the Label Assignment fields will automatically be entered in this section.

Logic polarity and numerical base may be defined appropriately for each label group independent of Pod boundaries.

Logic Polarity and Numerical Base field content may be selected from choices shown in parentheses under each field name.

Field content is changed by positioning the cursor in the desired field and then pressing the FIELD SELECT [ ] key.

All FORMAT SPECIFICATION label group parameters are automatically entered in other menus. The FORMAT SPECIFICATION may be recalled and edited at any time by pressing the k e y .

TRACE SPECIFICATION

MENU

- Positions a selected state at the [START], [CENTER], or [END] of the trace measurement.

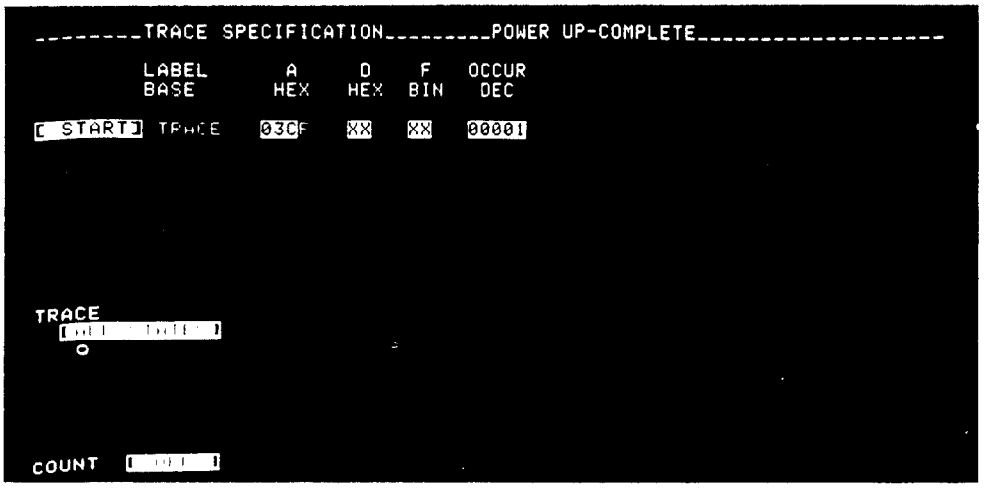
- Establishes a state sequence condition which must be satisfied before the trace measurement is made.

- Restricts the trace measurement to “ONLY STATES” which satisfy the given state conditions.

- Specifies a count of the occurrences of a given state; or time interval measurement of each state acquired in the data trace.

This Page Unfolds

TRACE SPECIFICATION MENU



LABEL BASE | A HEX | D HEX | F BIN | OCCUR DEC

Each label and its numerical base defined in the FORMAT menu is automatically entered in the TRACE SPECIFICATION menu.

An additional open field, OCCURrence, allows the operator to specify, in decimal notation, the number of times a state must be recognized before it is entered as valid data in memory. **NOTE: a 0 in the "units" position is not allowed.**

POSITIONING A GIVEN STATE IN THE DATA TRACE

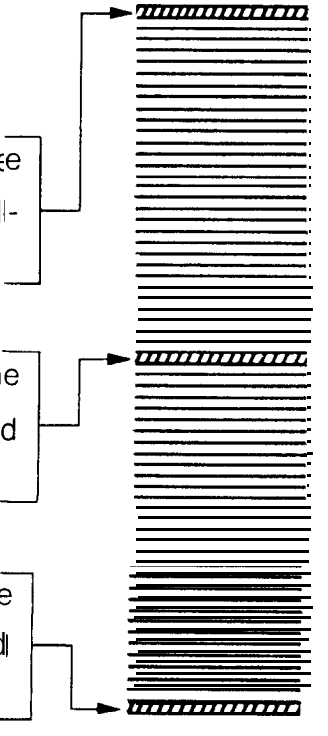
[START] TRACE 03CF XX XX 00001

Selectable field options:

[START]: Positions the specified state at the start of the memory; display shows the specified state and 19 following states.

[CENTER]: Positions the specified state at the center of the memory; display shows 9 preceding states, specified state, and 10 following states.

[END]: Positions the specified state at the end of the memory; display shows 19 preceding states and specified state.



Open fields permit entry of alphanumeric information that defines the desired state. If information is entered in two or more label fields, both states must be recognized simultaneously to initiate a trace.

Any assigned label may be used to define the trace state.

POSITIONING DATA TRACE IN PROGRAM FLOW

With the cursor located in the [ ] TRACE field, the key will insert additional lines to establish a state sequence of up to seven members.

Each member of a state sequence must be recognized in order (after occurring the number of times specified in OCCUR field) before it is acquired into memory.

When all members of the state sequence have been recognized in order, the trace state positions the specified state condition in memory when the trace measurement is executed.

When SEQ RESET field is ON, you may specify a state which, when recognized before the state sequence is satisfied, will restart the entire sequence search. Chapter IV gives examples of uses.

WHAT TO TRACE

This section of the display allows the operator to define which state(s) will be traced into memory after the state sequence is satisfied.

This condition of the selectable field indicates that the 1610A is to trace all states which occur after completing state sequence conditions.

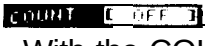
key has been used to add lines. Desired states can be entered and they instruct the 161 0A to gather only these states into memory. Additional lines may be entered using key so that [ONLY STATES] may be specified in the trace measurement.

Entering a decimal value in the OCCUR column instructs the 161 OA to count occurrences of each state in the TRACE section simultaneously. When any state satisfies the count specification, it is gathered into memory and the count is restarted on all states.

STATE/TIME COUNTS

With the COUNT field in this condition, the operator may instruct the 1610A to count occurrences of a specific state in program flow and store resultant count, along with data, during the measurement.

With the COUNT field in this condition, the 1610A counts time intervals between states. More information about state and time counts appears in the TRACE LIST MENU.

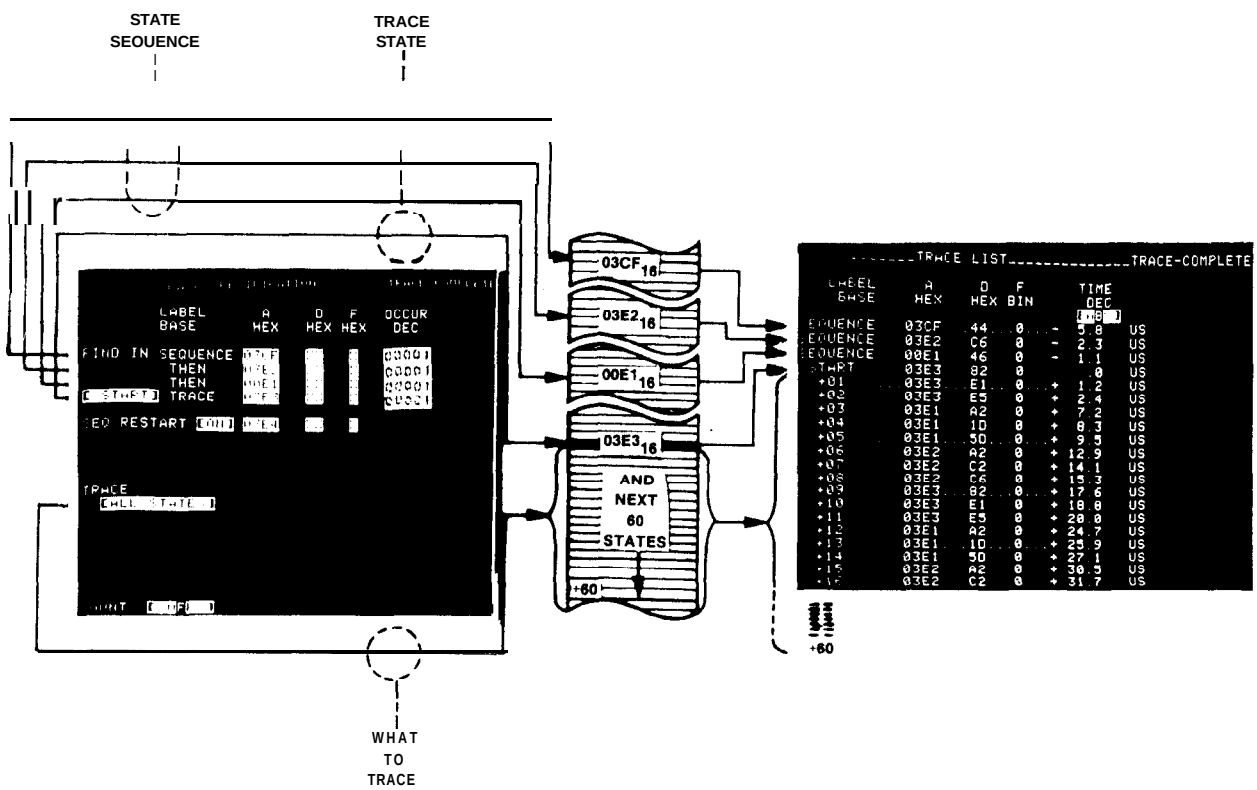


With the COUNT field in this condition, internal counters are not displayed.

------- SUMMARY -------

The following illustration specifies the starting addresses of three separate program blocks which must be recognized sequentially to arrive at the block of program to be investigated. As the program block of interest is entered at the trace state address, a trace is initiated. The next 60 states are gathered into memory with the trace state at the start.

Since each program block may contain many hundreds of program steps, this technique permits the operator to ignore thousands of program steps which are not pertinent to the desired measurement. You have, in effect, an apparent memory depth which is, for all intents and purposes, limitless.



Details Inside Fold

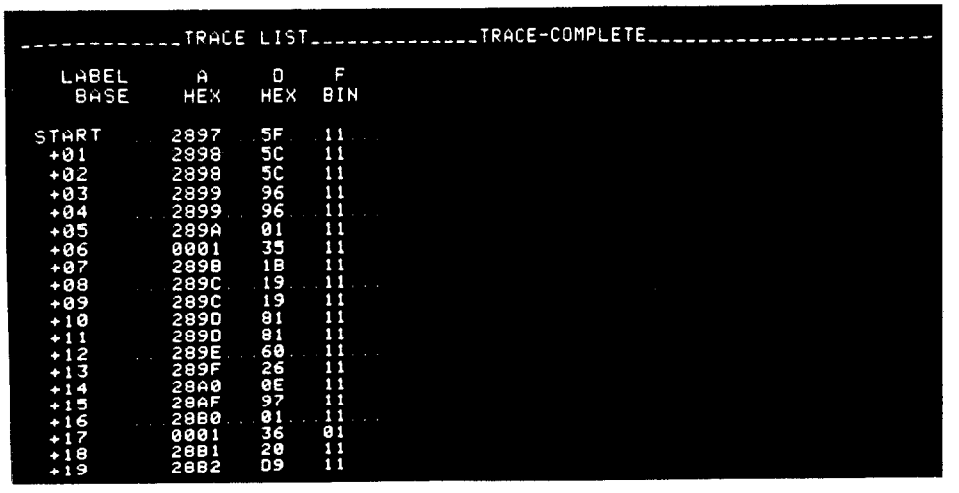
TRACE LIST

MENU

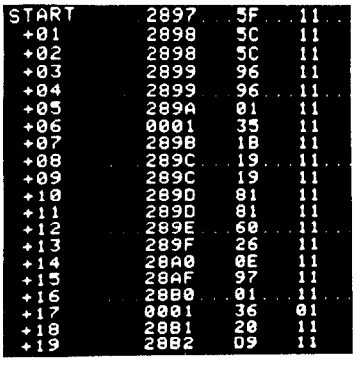
- Lists in memory all data in program flow and displays data according to FORMAT and TRACE specifications.
- Displays count of selected states.
- Displays time interval

Details Inside Fold

TRACE LIST MENU



All labels and their respective number bases defined in the FORMAT specification are automatically entered in the TRACE LIST menu when TRACE is pressed.

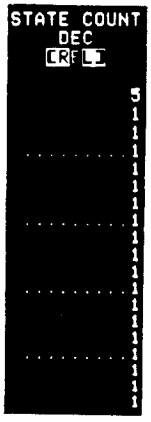


In the column at the extreme left, the word START designates the selected trace state and its position in the data trace. Decimal numbers following the word start are prefixed with the "+" symbol to indicate that they come after the recognized trace state.

Data displayed in each label column shows (in this case) address, data, and control or qualifier line information for each successive state traced into memory, For example, at line + 04, address 2899 shows data 96 and control line condition low.

The dotted lines in the display appear after each four lines for convenience in reading the display.

DISPLAY WITH STATE COUNT OR TIME COUNT

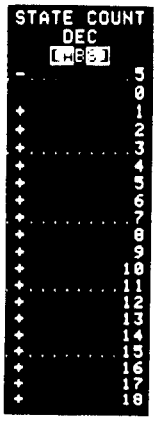


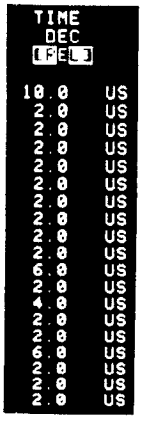
[REL]:

Shows count value RELative to previous valid state; i.e., five state counts between line one and line two. Count values always expressed in decimal notation.

[ABS]:

Shows absolute count value with respect to trace state. Count prefixed with "+" or "—" to show after trace state or before trace state respectively; i.e., "+18" means 18 counts after trace state.



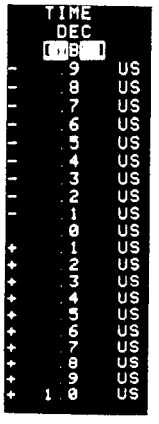


[REL]:

Time interval values shown are relative to previous time interval value; i.e., 10 μs between first time interval and next state. Values are expressed in μs, ms, or s in real time.

[ABS]:

Time interval values are shown with respect to trace state in terms of "—" (before) or "+" (after) trace state occurrence; i.e., +1.0 μs after the trace state.



Pressing recalls data stored in current memory. This makes it possible to recall current data at any time while examining other menus, until a new trace measurement is (executed.

See also TRACE COMPARE MENU or TRACE GRAPH for expanded use of this trace list.

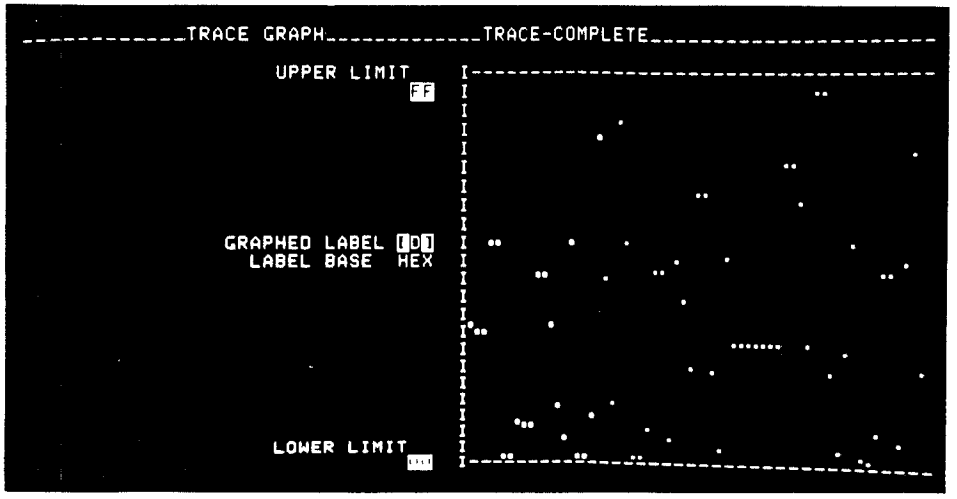
TRACEGRAPH

MENU

- Allows the operator to produce a graph of the data trace.
- Any label assigned in the FORMAT SPECIFICATION menu can be graphed.
- Graph may be viewed in single or continuous TRACE.
- Selectable upper and lower value limits for graphing.

Details Inside Fold

GRAPH MENU

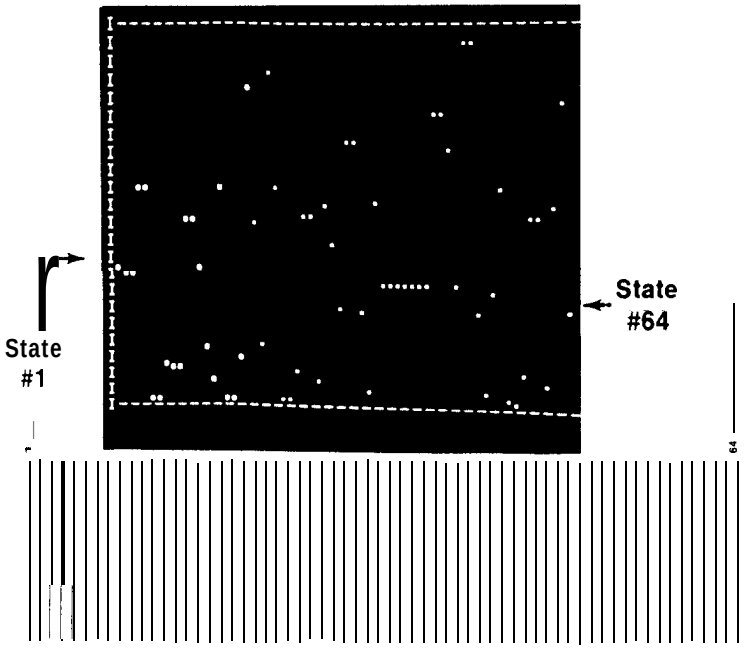


HOW THE GRAPH IS DERIVED

Each dot on the graph represents one state in the trace list.

The position of each dot is plotted on a horizontal coordinate representing the location of the state in the trace, starting with the first state at the extreme left, and the last state at the extreme right. The vertical coordinate represents the value of each state with respect to the pre-selected upper and lower value limits.

Horizontal Dot Positioning

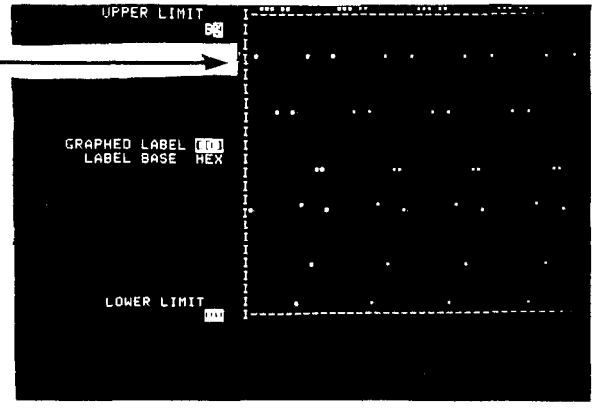


Vertical Dot Positioning

UPPER LIMIT FF – LOWER LIMIT 00

These open fields allow you to enter the value limits you desire within which the states are to be graphed, e.g.:

Assuming that hexadecimal values B9 and 00 have been assigned to the upper and lower limit respectively, this graph indicates that state 2 has a value of A5.



OFF SCALE DATA message will appear when one or more state values are outside the specified value limits as in the accompanying display.

Appearance of this message does not necessarily indicate a faulty measurement, it is only the machine reminder to you that some data inputs are not appearing on the graph.

GRAPHED LABEL 00
LABEL BASE HEX

This portion of the display indicates which label group is currently being graphed. Any label assigned in the FORMAT specification may be selected for graphing,

Use the FIELD SELECT [ ] key to select the label you wish.

Intensified Dots

Intensified dots on the TRACE GRAPH represent the twenty states displayed if you press the key. When the trace is rolled, these intensified dots will shift as the displayed trace shifts. In this way, it is easy to use the ROLL DISPLAY keys to locate and identify any specific dot of interest and read its actual value in TRACE LIST.

Dynamic Graph

By pressing the TRACE key and holding it down, you can watch dynamic program flow on the TRACE GRAPH in a continuous TRACE mode.

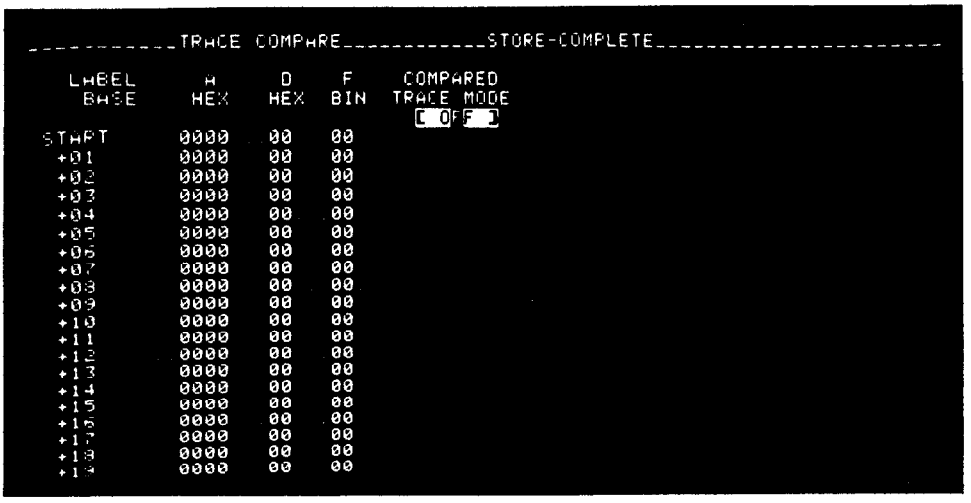
TRACE COMPARE

MENU

- Permits "EXCLUSIVE OR"ing of current measurement data with a stored standard.
- Permits continuous compare of current measurement data with a known standard with "Stop if Equal" capability.
- Permit continuous compare of current measurement data with a known standard with "Stop if Not Equal" capability.
- Permits "Exchange" of current measurement data with stored data for visual inspection or comparison.

Details Inside Fold

TRACE COMPARE MENU



A separate rnemory in the 161 OA is provided for storing a known-standard data trace. This standard may be derived from the trace list by pressing the key in the EXECUTE portion of the keyboard. This key causes current measurement data to be stored in the “compare” memory,

Pressing the key in the CURRENT MEASUREMENT DISPLAY section of the keyboard places the 161 OA in TRACE COMPARE mode and allows the operator a choice of three types of comparison.

With the selectable field in this condition, pressing TRACE causes an "EXCLUSIVE OR” comparison of current measurement data with the stored trace. All states in current measurement data which are the same as corresponding states in the stored trace are displayed as all zero’s Non-zero states differ from their corresponding states as shown in the display.

In this condition, pressing TRACE initiates a trace that continues until current measurement data is equal to the stored trace. While the measurement is in process, the instrument status message will flash "IN PROCESS" and "FAILED" until the specification is met. At that time, an audible signal is sounded, and the instrument stops showing a status message that reads "COMPLETE".

When TRACE is pressed, it initiates an action similar to the preceding except that inequality between current measurement data and stored valid data is being sought. When an inequality occurs, the instrument stops and displays a trace showing where the inequality is located.

NOTE

When a compared trace is in process, the blinking cursor disappears from the selectable field; this field cannot be changed until the search is completed or stopped.

NOTE

The selectable field must be returned to the "OFF" condition to obtain single or continuous trace operation.

This key enables the operator to exchange current valid data with a display of stored data. Neither memory is lost unless a new trace is initiated, at which time current measurement data in the memory is replaced.

Chapter IV

------- *POSITIONING THE TRACE WINDOW IN DATA FLOW* -------

Introduction

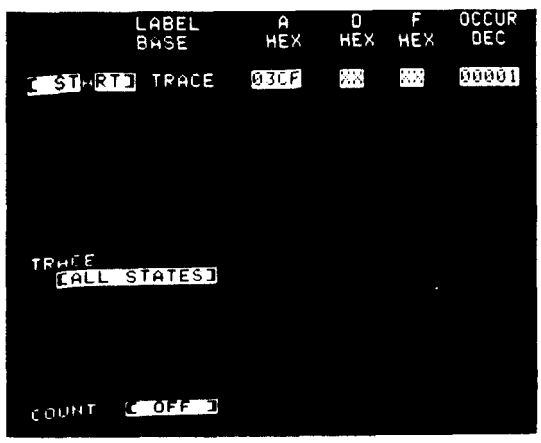
Most data programs are written in blocks, some containing loops, some containing branches, and some containing jumps so that there is no real “continuity” of program steps; each one may cover thousands of program steps. It can be an extremely time-consuming process to look backward in program flow to find a point of error.

The unique triggering capabilities of the 1610A make it possible to open a trace “window” on a specific location in program with pinpoint accuracy.

In the examples that follow, you will see how these triggering capabilities can be used to eliminate the need for examining hundreds of program steps which do not bear on the problem you are trying to solve.

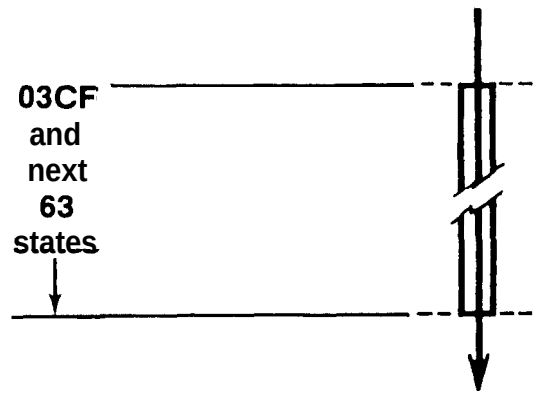
EXAMPLE 1: SIMPLE SINGLE-STATE TRACE

Trace Specification



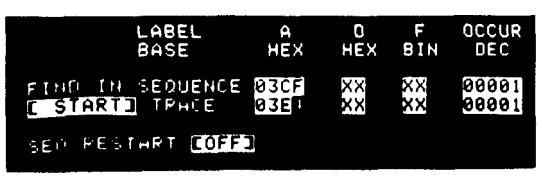
States in Display

Data Flow



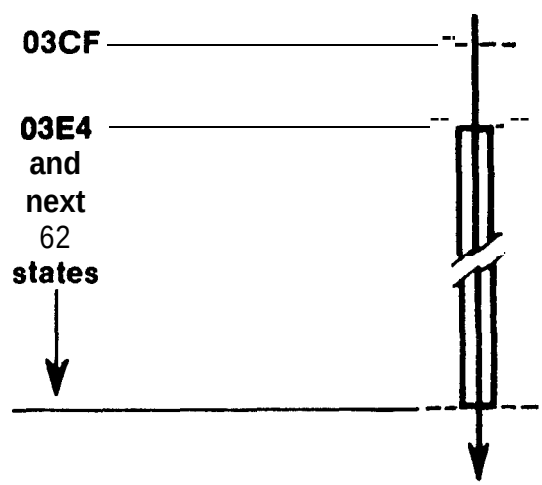
EXAMPLE 2: SINGLE-STATE TRACE WITH DELAY

Trace Specification



States in Display

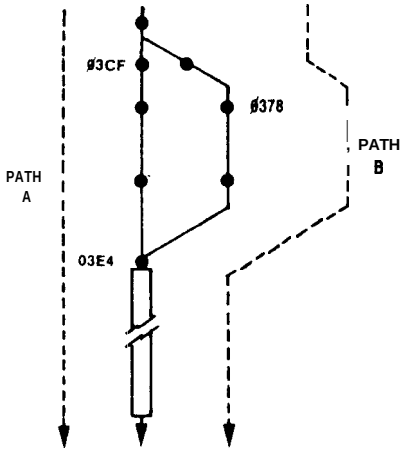
Data Flow



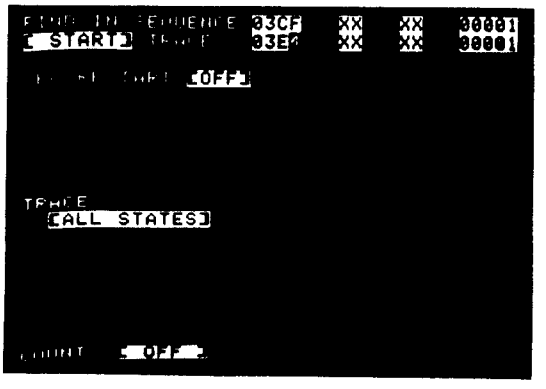
This technique locates the trace window in a desired block of program and concentrates on only that portion of the block of current interest.

EXAMPLE 3: TRACING SPECIFIC DATA PATH IN A BRANCHING PROGRAM

Frequently, activity in a given program location depends on which one of several program branches was followed to arrive at that location.



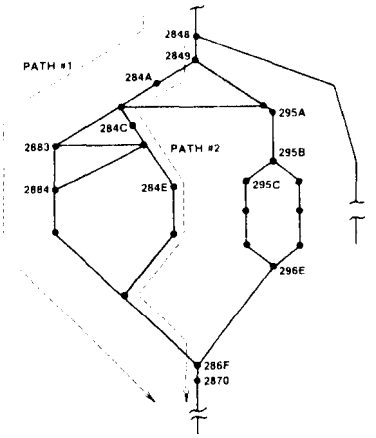
In the example given here, program address 03E4 is reached by Path A (03CF → 03E4) or Path B (0378 → 03E4). To ensure that program activity from 03E4 is traced only when Path A is followed, a state recognition sequence must be set up in the Trace Specification.



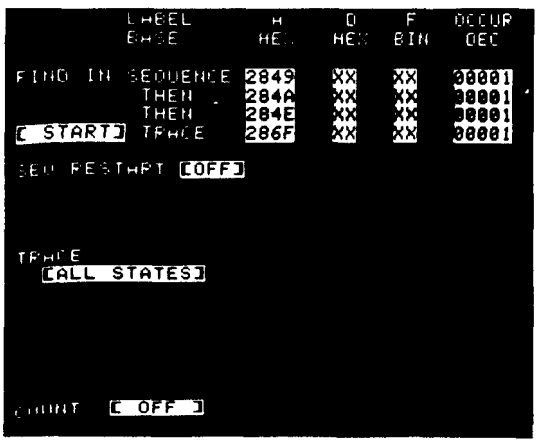
By specifying that the 161 OA must first recognize state 03CF, you are certain that when data is collected at 03E4 Path A has been followed. If the program flow branches through 0378, the Trace Specification cannot be satisfied, and no data will be gathered into memory.

EXAMPLE 4: TRACING A SPECIFIC PATH IN A MULTIPLE-BRANCH PROGRAM

More complex levels of network branching are commonly encountered. Analyzing sequential program flow in this example requires high-level sequential trigger capability.

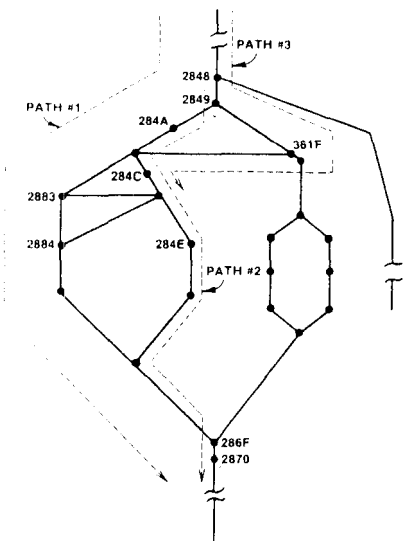


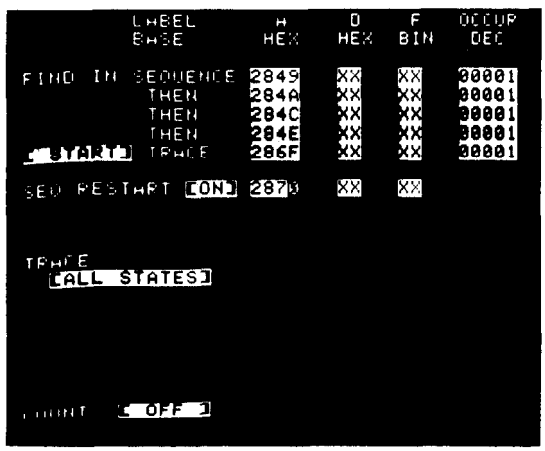
It is possible to trace program activity starting at address 286F after the program has followed Path #2 by setting a Trace Specification like this:



EXAMPLE 5: MULTIPLE-BRANCH PATH COMPLETED IN A SINGLE PASS

Often it is necessary not only to follow a specific path, but also to analyze program flow **only if** the path was completed in **one pass.** To examine this task, we can use the diagram and Trace Specification of Example 5.



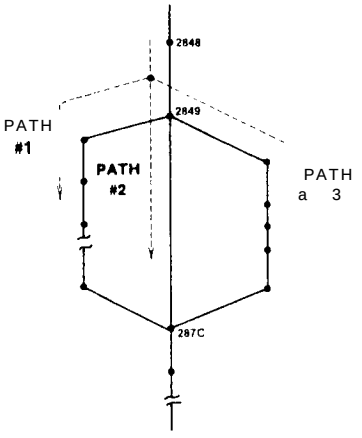


Specified this way, the program can satisfy sequence states 2849 and 284A and then exit the network at 286F leaving the 161 OA looking for the next occurrence of 284C. The program can reenter the network via Path #3, satisfy the remaining conditions vra 361 F, and the 1610A will capture data beginning at 286F. However, the captured data will be erroneous with regard to a Path #2 branch.

Set SEQUENCE RESTART in the Trace Specification to the ON condition and specify state 2870. Now, when Path #1 is followed 2849 and 284A are satisfied, but if the network is exited at 2870, the sequence search is restarted because a restart state was recognized **before all sequence** states were satisfied. If the network is entered by Path #3, the sequence search is restarted again for the same reason.

Only by following Path #2 is it possible to acquire data at exit address 286F, because only this path satisfies all sequence conditions **before** the restart state is recognized.

EXAMPLE 6: TRACING A DIRECT JUMP IN A MULTIPLE-BRANCH PROGRAM



Three common forms of program paths appear in this program flow diagram:

Path #1 is a path whose length depends on the operation being performed on a given pass;

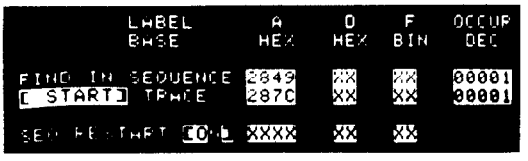
Path #3 is a fixed-length path because the same operation is performed each time this path is used;

Path #2 is a zero-length, or direct jump, path.

Defining a trace on Path #1 or #3 is easy using the sequential state trace specification 

However the zero-length Path #2 is not reliably defined this way because either of the other two paths satisfy the specification.

The solution is to use the SEQUENCE RESTART function to specify the desired path:

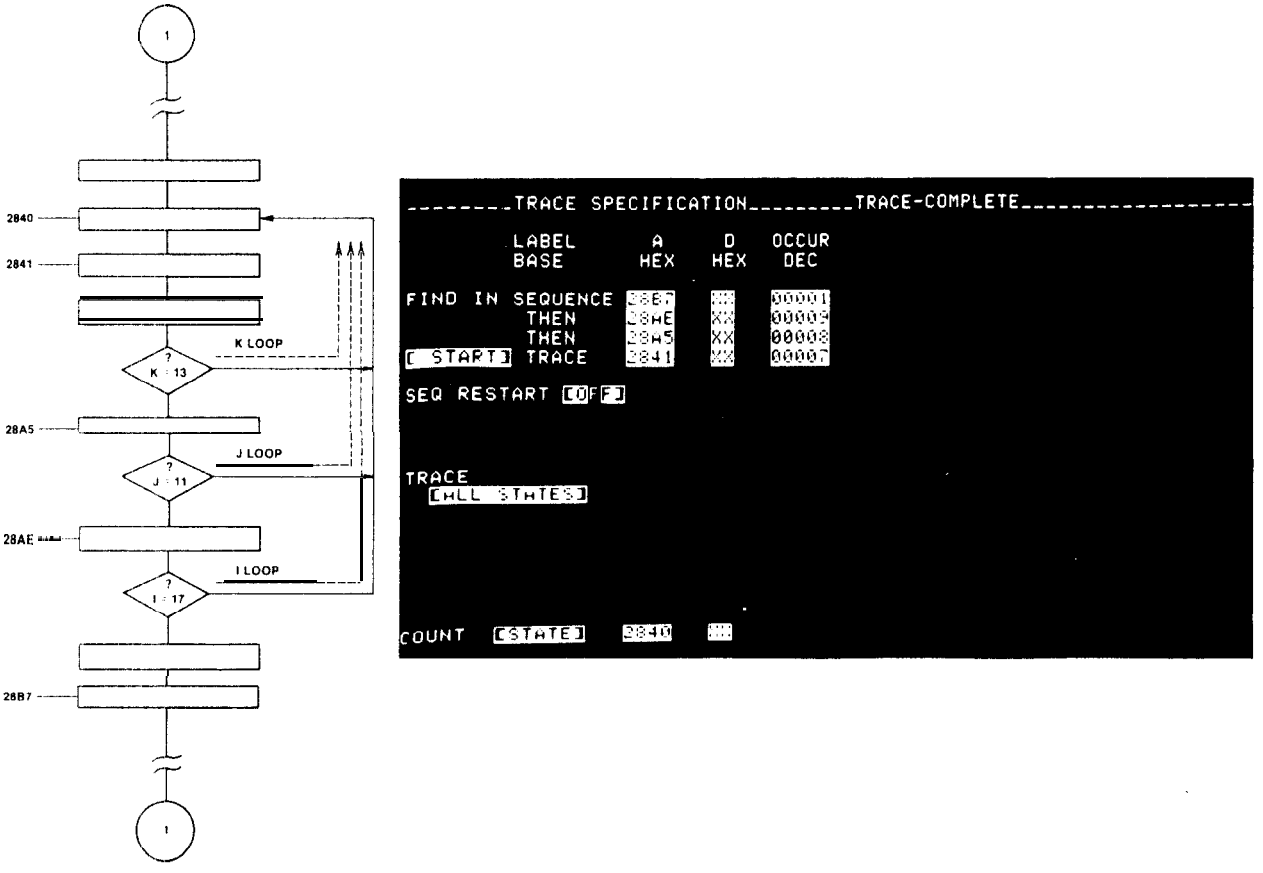


When state 2849 is recognized, the 1610A will examine the restart condition. If either Path #1 or Path #3 is followed, a state after 2849, other than 287C, is found, the restart condition (XXXX) is satisfied, and the sequence search is restarted.

A trace is captured only when 2849 is recognized immediately followed by 2876.

EXAMPLE 7: TRACING PROGRAM FLOW IN NESTED LOOPS

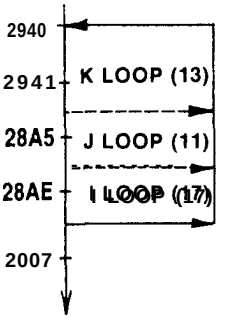
The 1610A is capable of examining program activity when it is working in the Nth pass of a sub-minor loop. The three-level loop in this diagram has a major loop (I) that iterates 17 times, a minor loop (J) that iterates 11 times for each occurrence of the I loop, and a sub-minor loop (K) that iterates 13 times for each occurrence of the J loop and 143 times for each occurrence of the I loop.



Using the trace specification shown above you can direct the 1610A to acquire data at state 2841 only **when** the program is in the 9th pass of the I loop, the 8th pass of the J loop, and the 7th pass of the K loop.

Notice that 2887 is to be recognized first. This ensures that when you start the measurement, the 1610A does not start in the middle of the loop and cause an erroneous count.

This capability is also helpful while developing a program. Once the program is written, it is run to verify completion of the desired task. Sometimes the task is eventually completed with non-desired tasks completed in addition. An example is this nested loop. To verify that the program actually completed only the specified number of loops, count the number of occurrences of state 2840 and compare with what was programmed to happen:



TRACE 7th PASS OF K
TRACE 9th PASS OF J
TRACE 9th PASS OF I

I	J	K
9	x 11	x 13 = 1287
	8	x13= 104
		7 = 7
		Σ = 1398

An ABSOLUTE state count will show that 1398 occurrences of state 2840 were actually counted, and that this section of program is performing as desired.

TRACE LIST ---------- TRACE-COMPLETE

LABEL BASE	A HEX	D HEX	STATE COUNT DEC [ABS]
SEQUENCE	28B7	86	- 1398
SEQUENCE	28AE	86	- 111
SEQUENCE	28A5	86	- 7
START	2841	00	0
+01	0000	00	+ 0
+02	2842	9B	+ 0
+03	2843	01	+ 0
+04	0001	03	+ 0
+05	2844	9B	+ 0
+06	2845	02	+ 0
+07	0002	07	+ 0
+08	2846	80	+ 0
+09	2847	03	+ 0
+10	2848	27	+ 0
+11	2849	04	+ 0
+12	284A	8A	+ 0
+13	284B	01	+ 0
+14	284C	84	+ 0
+15	284D	03	+ 0
+16	284E	CE	+ 0

Chapter V

PERFORMANCE VERIFICATION

------- *INTRODUCTION* -------

Intricate and complex measurements made on the system you are investigating require that you have complete confidence in the performance accuracy of your 161 OA.

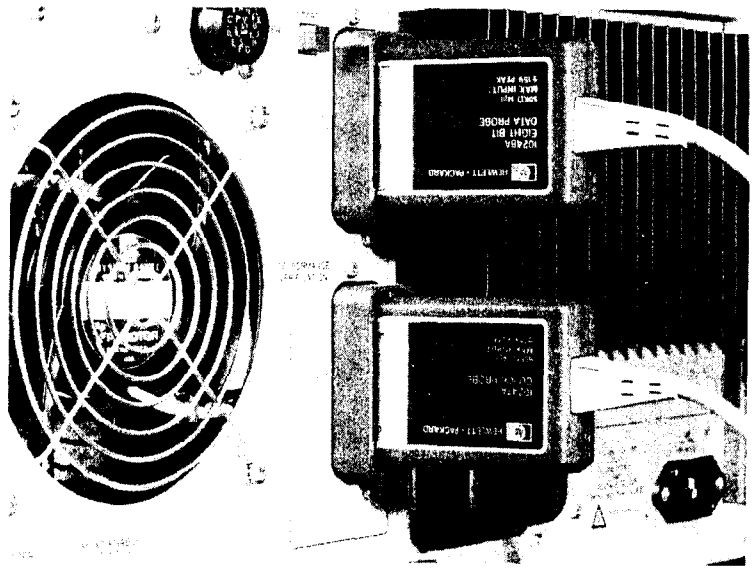
To inspire this confidence, a performance verification program is built into each 161 OA. You may call up this program at any time, and by following the simple instructions in each test display, assure yourself of accurate measurement performance by your 161 OA.

You have complete control over the flow of the tests and proceed from one test to the next only when you are satisfied that the current test is satisfactorily completed.

If your 161 OA is interfaced to an HP 9866A Printer, a print-out result of each test (except GRAPH) can be made.

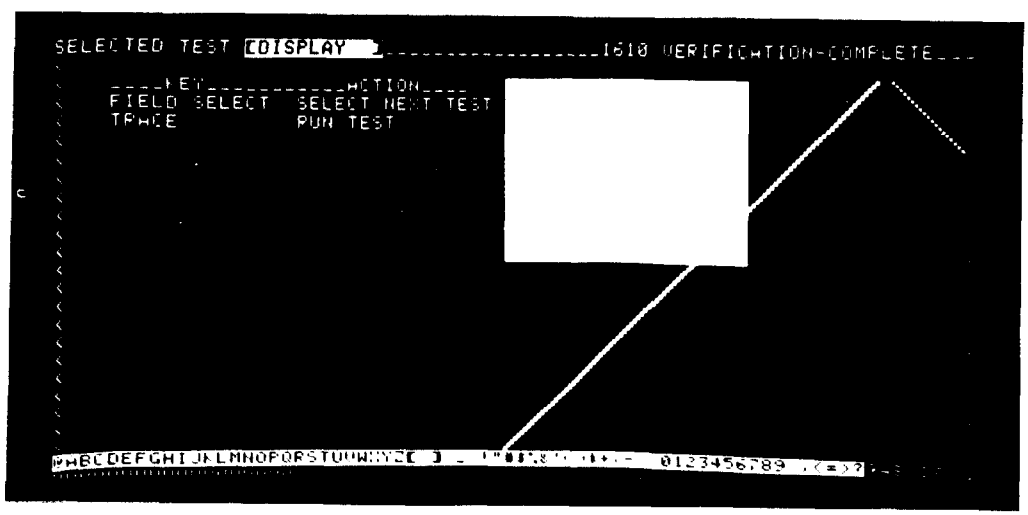
------- *INITIATION OF PERFORMANCE VERIFICATION* -------

With 161 OA power OFF, connect the clock pod and any one data pod, say POD 1, to its respective socket in the PERFORMANCE VERFICATION section of the rear panel.



Turn on 161 OA power and press the START pushbutton on the rear panel. Internal ROM and RAM tests are performed and verified then the next test is displayed. Each test display is described on the following pages.

DISPLAY TEST



Display Interpretation

As with all displays, line one shows the name of the display, and the instrument status with respect to that test.

Beginning on line 3, you are given a choice of actions and the keys to press to initiate each action. The key will re-run the test. The FIELD SELECT [ ] key will select the next test.

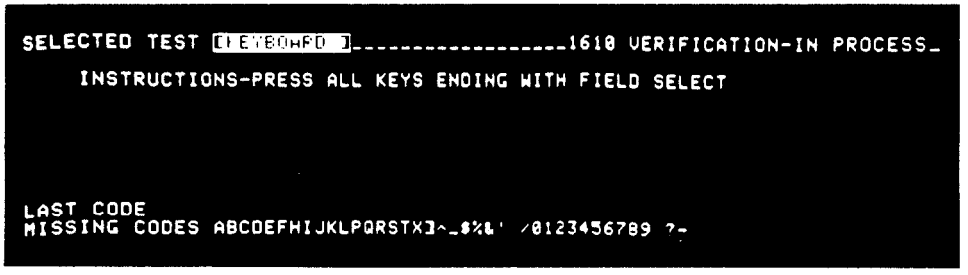
You can verify that various brightness levels are used and provide necessary contrast in the display.

Each character in the 161 OA repertoire is printed for verification that none are missing

The blinking cursor appears in the lower right hand corner to ensure you that it is operating properly.

Press FIELD SELECT [ ] and go on to the next test when you are satisfied.

KEYBOARD TEST



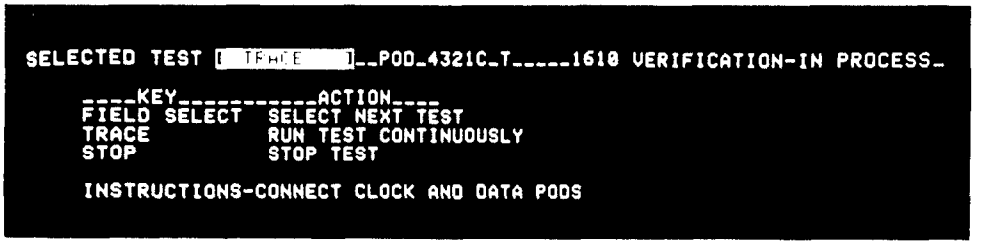
This test determines whether keys decode properly when manipulated.

The operator is required to press each key on the keyboard in no particular sequence except that FIELD SELECT [ ] must be the last key pressed to validate the test.

LAST CODE indicates which key was pressed last by displaying the code for that key. On the fold-out keyboard photograph, key codes for this test are shown in parentheses near the key to which they apply.

MISSING CODE indicates keys that must still be pressed to obtain a complete test, This test cannot be regenerated by pressing TRACE .

TRACE TEST



Unplug the CLOCK and DATA pods from the rear panel.

In the first line, notice the legend: ---POD-4321 C-T--. This legend indicates that no pods are connected to the rear panel, and the COUNT TIME function is inoperative. Plug in CLOCK pod and press TRACE The C-T- will disappear to indicate that the CLOCK pod is connected and also that the COUNT TIME function is operating.

Piug in the DATA pod and press then TRACE The respective pod number will disappear from the legend to indicate that this pod is connected and operating

Repeat 'with each data pod to verify correct operation.

Because only one date probe can be connected at a time, and each time the TRACE button is pressed, the test verification on line 1 will show FAILED. However, the procedure described above is verification of the proper operation of each probe.

INTERRUPT TEST

This test enables the internal Interrupt Request (IRQ) line and the test verifies that an interrupt is being received and processed by the internal microprocessor,

Pressing TRACE will cause this test to be run continuously.

Pressing [redacted] halts the continuous run and readies the instrument for the next test.

Press FIELD SELECT [ ] to advance to the next test.

PRINTER TEST

This is the final test in the PERFORMANCE VERIFICATION routine and is valid only if your 161 OA is interfaced with an HP Model 9866A Printer.

Each time this test is initiated and completed, the printer will print the line of characters shown at the bottom of the display.

Comparison of the printed line with the character line on the display will verify accuracy of the PRINT operation.

Upon completion of this test, pressing FIELD SELECT [ ] terminates performance verification and returns control to the operating system via the power-up routine.

Appendix A

GLOSSARY

ABSOLUTE (STATE-TIME):

A state count or time interval measurement in which each entry is in terms with respect to the trace state.

CLOCK SLOPE:

"+" indicates that data acquisition is initiated on the positive-going portion of the clock pulse (⌐).

"—" indicates that data acquisition is initiated on the negative-going portion of the clock pulse (¬).

CONTINUOUS TRACE:

A condition under which a measurement is traced continuously in accordance with specified limits. Memory is continuously filled with new data.

FIELD (OPEN):

An entry field in a menu whose content is made up of alphanumeric characters from the ENTRY section of the keyboard.

FIELD (SELECTABLE):

A menu field containing brackets ([ ]) whose content is limited by preset variables. Operator selection of field content is by use of FIELD SELECT [ ] key in the ENTRY portion of the keyboard.

LABEL:

An arbitrary character (A, B, C, D, E, or F) assigned to a group of adjacent input lines, regardless of pod boundaries, for ease of identification and display interpretation.

LOGIC POLARITY:

In positive logic polarity (+), an input high level = 1, an input low = 0. In negative logic polarity, an input high = 0, an input low = 1.

MEMORY:

Consists of 64 states gathered at the input lines in accordance with the operator-specified parameters and conditions.

GLOSSARY (Cont'd)

MENU:

A display on the CRT in which the operator has many choices among input signal parameters, state definition, etc. May also be a simple trace display such as TRACE LIST.

[REL]ATIVE (COUNT-TIME):

A state count or time interval measurement in which each entry is relative to the preceding valid entry.

STATE:

The logic condition at all valid probe inputs at a given clock transition.

STATE SEQUENCE:

A defined series of states which must be recognized in a given order before becoming valid memory transactions. A valid data trace can be enabled only after the state sequence is satisfied.

TRACE:

The 64 valid states gathered into memory under the constraints defined in the trace specifications. These states may or may not be consecutive depending upon selected specifications.

TRACE STATE:

The defined state which is positioned in the trace; i.e., the trace which is at the [START], [CENTER], or [END] of the trace.

TRACE WINDOW:

The twenty valid states in memory that are viewed on the CRT.

CURRENT MEASUREMENT DATA:

When a measurement trace is executed, 64 valid states are gathered into internal memory and constitute current measurement data. This valid current data will remain in memory, and can be recalled with the key, until the next measurement trace is executed, or until it is exchanged into an internal store memroy.

Appendix B

MESSAGES

ERROR MESSAGES

------- (Machine Response to Unacceptable Entry) -------

INVALID ENTRY:

Check for incorrect number base; unallowed entry at this cursor position.

OVERLAPPING LIMITS:

Check TRACE GRAPH upper and lower limits.

UNASSIGNED LABLE:

Refer to FORMAT SPECIFICATION for correct lable.

USE FIELD SELECT KEY:

Alphanumeric keys do not change a multiple-choice field.

WARNING MESSAGES

------- (Alerts operator that entry Is -------

Incorrect In present form)

COMMAND IGNORED:

Command has reached an execution limit; command does not apply.

GRAPH NOT PRINTABLE:

TRACE GRAPH not reproducible on HP 9866A/B Line Printer.

SLOW CLOCK:

System clock is not operating, or is operating at less than approximately 10 Hz. The 161 OA still runs and measurements are valid but may be very slow. This message simply alerts the operator.

SPLIT LABEL:

Assigned label must have continuous bit assignment, e.g., AAAABBBB not AAABBAA. Split label condition locks cursor in LABEL ASSIGNMENT field until corrected.

Message also appears while changing labels, but disappears when label assignment conditions are satisfied.

UNALLOWED VALUE:

Magnitude of specified value exceeds size of octal or hex label field assignment; or OCCUR value of zero not allowed; or a decimal field has mixture of digits and X's. Cursor locked to field until corrected.

8-LINE TRACE SPECIFICATION LIMIT:

Lines added to state sequence and states-to-be-traced must not exceed a combined total of eight.

------- 0 THER MESSAGES -------

$ MEANS X'S NOT DISPLAYABLE IN SELECTED BASE:

Digit(s) cannot be displayed in selected base; or, if a decimal field, the total field must be all digits or all X's.

OFF SCALE DATA:

At least one data point on the TRACE GRAPH is not within range of graph limits.

If data point is above upper graph line, its value magnitude exceeds the upper limit. If data point is below lower graph line, its value magnitude is less than the lower limit.

SEQUENCE RESTARTED:

Sequence restart state recognition before state sequence is satisfied causes complete sequence search to be restarted.

CURRENT MEASUREMENT DISPLAY

(H) (I)

(J) (K) (L)

ROLL DISPLAY

GRAPH (/) GRAPH (.)

ENTRY

FIELD SELECT [ ]

DON'T CARE

	D (D)	E (E)	F (F)
(-)	A (A)	B (B)	C (C)
X (X)	7 (7)	8 (8)	9 (9)
	4 (4)	5 (5)	6 (6)
0 (0)	1 (1)	2 (2)	3 (3)

EDIT

DEFAULT

(^) (=) (—)

GRAPH LIMITS

(?) (:)

CURSOR

(&) ($) (') (%)

EXECUTE

STORE CURRENT MEASUREMENT

STORED MEASUREMENT (R) (Q)

(P)

TRACE

(S)

(T)

Details Inside Fold