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TITLE	PST (POST STIMULUS TIME) AND LATENCY HISTOGRAM FOR THE LAB-8
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PST (POST STIMULUS TIME) AND LATENCY HISTOGRAM FOR THE LAB-8

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ABSTRACT

The LAB-8 Post Stimulus Time (PST) Histogram program records all signals crossing a set threshold after a given event. This program is used most frequently in experiments dealing with the response of a single nerve cell to a stimulus. After the primary event (S1) e.g., a stimulus, the program measures the time of occurrence of all subsequent events (responses) above a certain analog threshold. The PST Histogram represents the sum of all activity following a stimulus. It is not an analog summation (signal averaging) but an event summation which can be interpreted as a distribution of the probability that an event will occur at time T following a stimulus.

The Histogram is displayed on the oscilloscope as a plot of frequency of event (y) versus time (x). This program allows the user to specify the number of firings following a stimulus to be recorded, the resolution of the time axis (bin width), the duration of the time axis (number of bins), and the range of the time axis (the minimum time which must pass after the stimulus before analysis begins). A listing of this program is available through DECUS.

REQUIREMENTS

- PDP-8/I or 8/L with DWØ8A I/O Conversion Panel
- AXØ8 Laboratory Peripheral
- RM5Ø3 Oscilloscope
- LAB-8 PST Histogram Program
- High Speed Reader/Punch is used when available

THE PROGRAM

The PST and Latency Histogram Program is designed to give information about the activity which follows a stimulus or synchronizing event. The activity is defined by a signal which will fire a Schmitt trigger (the characteristics of a signal which cause a firing are described in the section entitled CONNECTIONS). It is this event (the firing) and its time of occurrence which are detected by the program. In addition to recording the time of occurrence of events following a stimulus, the PST and Latency program can show a zeroth Histogram. This is a graph showing how much activity followed each stimulus. The Y axis is frequency of occurrence where the X axis is divided into units of epochs (1 epoch = 1 unit). This feature is useful in checking to see if the overall activity following a stimulus remains constant through time or decreases due to habituation or fatigue.

Before data collection can start, the scheme for recording events and their time of arrival must be defined.

Latency: a post stimulus time histogram is a record of all activity following a stimulus for a set period of time. In certain studies, it is desirable to have a record of only the first few nerve potentials following a stimulus. This is called a latency histogram. The number of potentials recorded following the stimulus is called the order of the latency histogram. This program can form either a PST or latency Histogram.

Time Scale: Since the LAB-8 is a digital device time must be counted in increments rather than as a continuous function. The finer the increments are, the more closely the real situation is approached. The majority of biological phenomenon occur slowly enough that this departure from the real time world does not impose severe restrictions. Therefore, the first parameter we must assign is the time scale increment, or resolution. This is called the bin width. Since the clock in the LAB-8 ticks at intervals of 100μsec., bin widths are defined in multiples of 100 μsec.

Once the units of the time scale are defined, the length and range of scale must be assigned. This is done by supplying the number of bins which should be recognized (i.e.(bin width) x (number of bins) yield time scale length) and time at which the time scale should begin. The latter parameter is defined in answer to the question "minimum time?" (where minimum time is in terms of bins).

As an example: A histogram is defined as having bin widths of 5.Ø ms (5Ø x 1ØØ μsec). It consists of 1ØØ bins and has a minimum time of Ø bins. The time scale would start at time zero (time zero is defined by the occurrence of the stimulus), and range in increments of 5 milliseconds to time = 5ØØ ms (5.Ø ms x 1ØØ). If a minimum time had been specified, the starting and ending times of the range would be incremented by that amount (e.g., minimum time = 2 bins; therefore 2 x bin width = 1Ø ms total delay of the start of the range; thus the range would start at 1Ø ms and end at 51Ø ms).

Minimum time is used usually for one of two reasons. Either it is used to avoid artifacts which the stimulus might cause or it is used to move the time scale to the time of interest (i.e., if precise measurements had to be obtained at a specified time after the stimulus and no other time was of importance in the study).

Once the time scale is defined, the only other parameter that must be specified before data taking can start is number of times the stimulus will be presented (number of epochs). This feature is useful in studies where the nerve cell is prone to fatigue. After the set number of stimuli is presented, the program will notify the user and he can either output his data or return and take more data.

CONNECTIONS

A lead which contains a synchronization pulse (a pulse occurring at the same time as the stimulus) should be connected to the BNC input connector S1. A second lead which contains the response activity should be connected to the BNC input connector S2. S1 and S2 are two of the Schmitt triggers of the LAB-8. The Schmitt triggers are threshold detectors and can accept pulse or analog inputs. In either case, the circuit will fire when the trigger threshold has been exceeded in the negative direction after having been Ø.7V above the trigger threshold. The trigger threshold is set with the knob to the left of BNC input connector. This threshold varies between -.5V (full clockwise) to -2 .5V (full counterclockwise). The input to the Schmitt trigger must be kept to within ± 1Ø Volts. For a technical description of the Schmitt trigger, see Appendix A. During the trigger initialization section, a lead containing an analog signal may be connected to analog input 1 or 2 but this is not necessary during the remainder of the program.

PROGRAM LOADING

The Binary Loader is used to load the PST Histogram program. Check to see if BIN is in core; if location 7777 contains 53Ø1, BIN is present. If BIN is not present, refer to Appendix B for loading instructions. (For loading the PST program from a mass storage system, follow the instructions given in the monitor handbook.)

To load the histogram program, use the following procedure:

a. Place the histogram tape in the tape reader.

b. Set the SWITCH REGISTER to 7777_8.

c. Press the LOAD ADD key.

d. If using a high-speed reader, set the SR to 3777_8.

e. Turn the Teletype to LINE.

f. Turn the scope to ON.

g. If using a low-speed reader, set the reader switch to START.

h. Press the START key on the computer.

i. After the tape has been read in, set the SR to Ø2ØØ.

j. Press the LOAD ADDRESS key.

k. Press the START key.

RUNNING THE PROGRAM

After the tape has loaded in verify that the accumulator lights are all off. If they are not all off, there has been a reader error and the program should be reloaded. After loading is complete and correct, set 200 in the switch register, press LOAD ADD, then press START. At this point, the Teletype will print out <u>TRIGGER</u>. (All further letters typed by the computer will be underlined in this document.)

1. Trigger Initialization

At this point, the user should adjust the Schmitt trigger thresholds (described in section on CONNECTIONS) by moving the knobs to the left of the inputs so that the triggers are firing on data and not noise spikes. The trigger thresholds should be adjusted individually to avoid confusion, so during the initialization only one lead should be connected to the Schmitt trigger inputs at a time.

When the trigger fires, the scope will show a line across its face. The user can tell by the presence or absence of this line whether or not the Schmitt trigger is firing. If the user wishes he can attach a line in parallel (with the line going to the Schmitt trigger input) to the analog input bearing the same number. Now, whenever the trigger fires two traces will appear on the oscilloscope. One is a sweep of the analog input (corresponding to the trigger that fired) and the other is a base line to represent the voltage at which the trigger fired. This feature is useful if a slowly varying analog signal is used to fire the trigger. By viewing the input, the user can see where on the wavefore his trigger is firing. The sampling rate of the analog channel is set by the range and fire controls on the right hand side of the AXØ8. Once the trigger thresholds are set satisfactorily, all leads except S1 and S2 should be removed to avoid confusion.

TYPE the Return Key to advance the program.

NOTE: After the program has left the trigger section, it is impossible to return to this section under program control. The program must be restarted by the switches at location 7445. If data has been collected, this section may have been overwritten by data. If this is the case, the program must be reloaded to recalibrate the Schmitt triggers.

Parameter Setup

The user must now define the Post Stimulus Time or Latency Histogram by answering a series of questions. The question will be asked and the user must respond in the format described below. All answers must be followed by a CARRIAGE RETURN. Leading zeros are not required. If the question is improperly answered a "?" will be typed and the question will be reasked. If the user wishes to back up one question to redefine a parameter, he should strike the LINE FEED key. If a mistake in answering is made and he wishes the current question reasked, he should type the RUB OUT key. If he wishes to redefine all of the parameters, he should type ↑ A. (This is read, "control A." It is typed by holding down the CTRL key and typing A.) ↑ C will return control to the monitor (if one exists) at any time during the program (if no monitor exists, the user should refrain from issuing this command).

Question 1

PST? First of all the program wants to know if the user wishes to form a Latency Histogram or a PST Histogram (for description, see Section THE PROGRAM).

Answer Y (for yes), N (for no) followed by the RETURN key (return is signified by ↲).

If Y↲ is the answer, question 2 will be skipped and question 3 will be asked. If N↲ is typed, the following question will be asked.

Question 2

ORDER= For a Latency Histogram, the program must know the number of threshold crossings following the stimulus to record. If a frequency distribution of the first pulse following a stimulus is desired, "1" should be typed. For a distribution of the first 2 pulses, "2" should be typed, etc.

Answer — A number between Ø and 4Ø95. This signifies the number of pulses to record following the stimulus. If all of the pulses following are to be recorded, Question 1 should have been answered "Y".

Question 3

BINW= — The question is asking for the Bin width. The bin width is the basic time unit time scale used in building the histogram.

Answer — A number between Ø.1 and 4Ø9.5. The number is interpreted as milliseconds and must be in the form x.x↲.

Question 4

BINS= — The number of bins and bin width determine the range of the time scale.

Answer — A number between Ø and 1891. If more bins are requested, there will not be enough core for data storage; the message "CORE?" will be typed then the question will be reasked.

Question 5

EPOCHS= — The final question is to define the number of times the stimulus will be presented (the number of epochs).

Answer — A number between Ø and (1891 - # bins). Again, it is possible for this answer to request for more core than is available. The 0th histogram is a graph showing how many firings were recorded consequent to each stimulus. Therefore, a core location is needed to record the count for each epoch. If core is exceeded, the message "CORE?" will be typed and the question reasked. Simply reduce the number of epochs or the number of bins until the answer is accepted.

Question 6

MINTIM= — This question asks the starting time of the time range under consideration.

Answer — A number between Ø and 4Ø94. The units are bin widths.

After the last question is answered, the program will wait for ↑S to start data collection. (↑A will reask all questions, ↑C will return to monitor). For an example of parameter setup, see Appendix C.

DATA TAKING

After the questions have been answered, the user should type ↑S to start data taking. The LAB-8 will now start displaying the first histogram. This is the PST or Latency histogram which records the responses and their times of arrival following the stimulus.

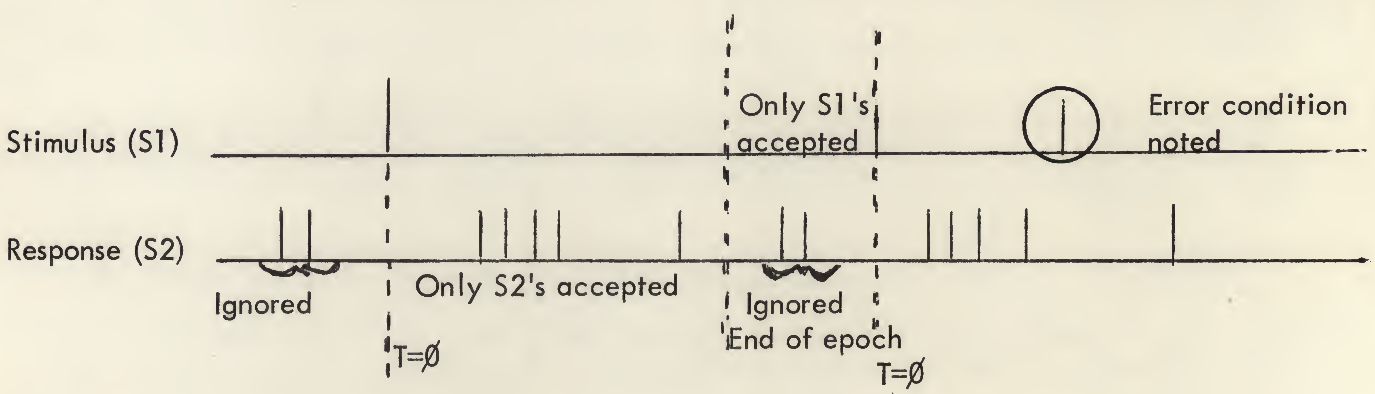
The X axis of the display is the time range. On starting this section, it consists of all the bins which were requested. These bins are shown with zero content at first so that their height is coincident with the base line. As responses are registered, the bins will show themselves. If a minimum time is specified, the first bin on the left hand edge of the X axis is the underflow bin. That is, this bin records all responses that occur at some time before the specified minimum time has elapsed. If no minimum time is requested, there will be no underflow bin and the first division of the X axis will be the first bin of the time range.

NOTE: The counts that fall into the underflow bin are not recorded in the zeroth histogram. The zeroth histogram records only those counts that occur during the specified time range.

The Y axis is also shown as a straight line. It differs from the X axis in that it contains 25 hatch marks equally spaced 2Ø raster points apart. These marks are provided so that bin content can be estimated visually during data taking. These hatch marks will remain the same distance apart regardless of the Y scale factor.

The user has one other display which he can view. This is called the zeroth histogram. To see this, "<", should be typed. This histogram is a graphical representation of the number of pulses which are received after each stimulus. The X axis here has an increment for each epoch (rather than for each bin). The first epoch is shown at the left hand end of the X axis. This histogram is useful for determining the gross activity of the neuron through time.

The display will remain active during data collection. The collection algorithm is the following. The program waits for a stimulus, S1 (Schmitt trigger 1). Until a stimulus is recognized, no responses will be acknowledged. When S1 is received, the program will accept only responses (S2's) until the end of the time range is reached (i.e., unit time = mintime + (# of bins x bin width)). During this time, no S1's will be acknowledged, so the user should make sure that the stimulus repetition rate is slower than the length of the analysis time period. The following diagram describes the timing relationships and the signals that are acknowledged.



From the diagram it is clear that only those response pulses occurring during the analysis time are counted. An error condition is noted if an S1 (stimulus) is received during the analysis period. The time counter does not reset to zero so the S1 is effectively ignored. The occurrence of the untimely S1 is noted and is reported at a later time.

If, at any time during data collection the contents of a bin in the histogram exceeds 4096, the overflow is noted and the contents are set to 4096. Every time a bin is filled over 4096, the bin is set to its maximum and the overflow is noted. At the end of data collection, the errors are reported.

COMMANDS DURING DATA COLLECTION

During data collection there are several commands which can be executed. Most of these commands operate on the display. The following is a list of possible commands. They are called "Group I Commands." NOTE: Although the display is changed the data remains unaltered.

COMMAND	ACTION
>	This causes the display of the next highest histogram. In the present PST Histogram program there are only 2 possible histograms to display. Therefore this command will only move the display from the 0th to the 1st histogram.
<	Same as > but moves the display back one histogram. N. B. The display will not be forced to display non-existent histograms by repeating these commands.
↑ Z	Stop data collection. Zero out all buffers. Wait for ↑ S to restart collection.
↑ A	Go back to parameter setup and Alter parameters.
↑ Q	Quit data taking at the next end of epoch and transfer to output mode (data taking can be resumed, saving all data by ↑ R, ↑ S).
↑ P	Panic Stop. Immediately transfer to output mode. Do not wait for end of epoch or anything else.
↑ C	Immediately return to monitor (this command should not be used if System monitor does not exist).
C:	Each time this command is issued, the display alternates between displaying Cursors or no Cursors. The cursors are two vertical lines which are controlled by analog knobs 0 and 1. Their relative position is unimportant.
U	Scale the dimension Y Up by a factor of 2. This does not effect the actual bin values. Only the display.

COMMAND	ACTION
D	Scale Y Down by a factor of 2. (U and D may be given any number of times)
E	Expand the area of the histogram enclosed by the cursors so that the area takes up the entire X axis. (E may be done any number of times).
B	Return to the Beginning expansion factor (i.e., no expansion). In other words, disregard all E commands.
S:	Before display, sum adjacent bins. This command adds adjacent bins and displays the resulting histogram. This effectively doubles the bin width. It also can be considered a type of smoothing routine. At the start of the program, the sum factor is set to one. Each time the S command is executed, the sum factor is increased by one. When sum factor =1, each bin is displayed separately; when Sf=2, two bins are added together and displayed on one. When Sf=3, three bins are added together and displayed as one, etc.
O:	Original Sum Factor - Set sum factor to 1 or return to Original Sum factor.
Z:	Zero all display changes or set all displays to unmodified state.
A:	Each time this command is issued, the display alternates between displaying an Axis or no Axis. This command is included for aesthetics only. Its sole purpose is to yield a clearer display.
V:	Each time this command is given, the display switches between Viewing the histogram in a bar graph display or a point plot display.
↑ U:	This is an undefined User command which can be implemented by following the instructions in Appendix D. Unless the program is modified, it will have no effect.

After data collection is complete, the program will transfer to the Output mode. This transfer takes place after the user-specified number of epochs is complete or ↑ Q or ↑ P is typed during data collection. The computer will type CARRIAGE RETURN LINE FEED, "OPM", CARRIAGE RETURN LINE FEED, two four digit numbers, and then resume the display.

Error Condition Notification: The two four digit numbers that are typed out represent the number of times two types of errors occurred during data collection. Error condition one (the first number) arises if an S1 or stimulus pulse is received during an epoch (see diagram on page 6). These S1 pulses have no effect on the data collection, but are noted as errors and reported here. Error condition two (the second number) arises if the contents of any bin exceeds 4096_{10}. Each time the overflow occurs, it is noted, and the bin content is reset to 4096.

At this time, all of the Group I commands are still active as well as the following set of Group II commands:

COMMAND	ACTION
T	Type out the data enclosed by the cursors. Before the T command is issued, the cursors should be placed so that they surround any area of interest. When "T: is typed, the scope will go blank and the Teletype will type out the contents of the bins between the cursors. If the cursor line goes through any part of a bin, that bin will be included in the typeout. Until the user is familiar with the typeout portion of the program, the following procedure is suggested. Bring up a bar graph display. Position the cursors on the bins that delimit the area of interest. Type "T". A sample of the output is the following:

```
1   ØØØ1        ØØØØØ1Ø   ØØØØ229      .Ø436   ØØ53   ØØ56

ØØ53   ØØØ6   .6ØØØ   .Ø262
ØØ55   ØØØ2   .2ØØØ   .ØØ87
ØØ56   ØØØ2   .2ØØØ   .ØØ87
```

Starting with the leftmost number on the first line, the interpretation is:

(1) The histogram being typed out is the first order histogram. (Not zeroth) (ØØØ1) The sum factor is ØØØ1. (ØØØØØ1Ø) The total number of counts between the cursors is 1Ø. (ØØØØ229) The total number of counts in the entire histogram is 229. (.Ø436) The ratio of the number of counts between the cursors to the number of counts in the entire histogram is .Ø436 to 1 or 1Ø/229. (ØØ53) Bin number 53 is the left most bin being typed. (ØØ56) Bin number 56 is the rightmost bin. On the second line, (ØØ53) - Bin number 53 contains 6 (ØØØ6) counts. (.6ØØØ the ratio of the number of counts in this bin to the number of counts between the cursors is .6 to 1 or 6/1Ø. (.Ø262) the ratio of the number of counts in this bin to number of counts in the entire histogram is .Ø262 to one or 6/229. Each bin is reported in this manner. If a bin has zero contents, its typeout is skipped. In this example, bin #54 was omitted because it contained nothing.

N.B. If a minimum time is specified, then bin #Ø represents a count of all S2's occurring before the minimum time is elapsed. It is the Minimum Time Bin (or underflow bin). If no minimum type is specified, then bin #Ø is the first bin of the histogram. The total number of bins displayed is always equal to the user-specified number.

Another fact to be considered is that when the histogram has been subjected to the Sum command, the bin numbers refer to the bin numbers of the original, unaltered, histogram. The bin number typed out refers to the leftmost bin that is summed with its neighbors on the right. Example:

bin 1Ø	has 4 counts
bin 11	has 3 counts
bin 12	has 8 counts
bin 13	has 5 counts

If S is typed once and the T command is then issued, the typeout would be the following:

bin 1Ø;	7 counts
bin 12;	13 counts

Note: When S has been typed, a skipped bin number does not necessarily mean a bin of zero contents. Similarly, when the E command is executed, followed by "T", the bin #'s refer to the original unaltered histogram.

K Calibrate an X-Y analog plotter. When the K command is given, the outputs of the oscilloscope go to zero volts for the horizontal and zero volts for the vertical. When any key on the keyboard except ↑ Q ——> is struck, the outputs each go to -1Ø volts. By striking any other key, the outputs will go back to zero volts. This process may be repeated as many times as needed while the bias and gain controls for the X-Y plotter are adjusted (see Appendix F for details of attaching an analog recorder). When the plotter is calibrated, ↑ Q should be typed and the display will be resumed.

P This command is used to plot the histogram being displayed on an analog X-Y recorder. The histogram will be plotted in the exact scale as it is displayed, in bar graph form, with an axis and no cursors. After the initial command, the program waits for the user to turn on his plotter and lower the pen. At this time, the timing control on the AXØ8 should be adjusted. Turn the range knob fully counterclockwise then turn it clockwise three positions. Now type any key on the keyboard and the axis and histogram will be plotted. The speed of the pen can be controlled with the timing controls on the AXØ8. The fine control knob can be adjusted while the plotting is taking place. However, the course knob should not be moved while the pen is down, for its movement will cause the pen to jump.

When the axis and Histogram have been plotted, the program will again pause. The user should now raise the pen and turn off the plotter. If the plotter is on while the display is active, the pen will shake furiously, trying to keep pace with the changes in analog voltages. When the plotter is turned off, type any key and the display will be resumed.

↑ B: Causes a binary dump of the histogram being displayed. Note: the histogram will be returned to normal size and scale before the binary dump takes place. After the initial command of "B", the computer will type "HIGH?". The user should answer "Y ↓ " (for yes) if the dump is to proceed on a high speed punch or "N ↓ " if the Teletype punch is to be used. After this initial question, the computer will type ID. Here the user may enter a maximum of 5 characters followed by a carriage return for an identification code. Caution - the following characters may not be used in the ID code.: Rub out, ↑ C, or ↑ A. A line feed at this point will reask the question HIGH? . The pressing of the Rubout key will cause reasking of the ID question.

After the ID code has been entered, 64 leader trailer punches will be punched. If the low speed punch is to be used, it should be turned on during the leader trailer. Following the leader trailer code, the ID code will be punched in ASCII and will be followed by another 64 leader trailer punches.

After the identifying information has been output, a core image of the display list (the pertinent information relating to the histograms for display purposes), a core image of histogram (which was being displayed when the ↑ B command was executed), and a checksum will be punched. A core image dump allows the paper tape to be read back into the computer in the same form as it was originally dumped. The binary loader can be used to reload the data. This feature allows the user to take data, dump it and then return at any later time to process it or review it. The user may write his own processing program or he can read the data back into the PST and Latency Histogram program. For details of binary format, see Appendix E. To review the data with the PST program, read in the program as described in the section on PROGRAM LOADING (if the program in core, reloading is not necessary). After the program is in core, load the data with the binary loader using the same procedure as if the main program were being loaded. After the data and program are in core, start the program at location 1366 (place 1366 in the front switches. Press LOAD ADDRESS and start). Now operate the program as if the output mode had just been entered. Note 1: Since the ↑ B command dumps only the histogram being displayed, only one histogram will be displayed properly after data read in. Note 2: If this program is run from Disc or DECtape, the histogram can be dumped by the following procedure.

1.) Hit ↑ C - monitor returns.

2.) Save locations 4ØØØ——>76ØØ as a binary file.

3.) Restart the program at location 1366.

4.) Continue as if a binary dump had taken place.

To review this data, load the PST program then the data. Start at location 1366.

After the binary dump has taken place, the program returns to the active display and all of the commands are operative.

↑ I — This is a user Group II command which may be Implemented in the same manner as ↑ U. See Appendix D. Until a patch is made to implement it, issuing this command will do nothing.

TO RETURN TO DATA COLLECTION

↑ Z — as mentioned before, will zero all buffers and error counters.

↑ R — will Retain the data in the buffers so that data collection may be resumed without loss of data. The effect of this command on the 1st order histogram is to allow it to accumulate another preset number of epochs. The effect of this command on the zeroth histogram is to set the epoch pointer back to zero. That is, the first bin will be incremented by the number of pulse received during the next epoch. The error counters are not reset.

↑ S	This command should follow either ↑ R or ↑ Z to start data collection again.
↑ A	Return to redefine parameters

Before using the program, the user should thoroughly familiarize himself with the following Group I and Group II command summary table so that the program may be used most effectively.

<u>Group I.: Commands For Data Collection and Output</u>

>	Increase order of display
<	Decrease order of display
↑ Z	Stop, zero buffers wait restart
↑ A	Stop, return to alter parameters
↑ Q	Quit taking data after next epoch
↑ C	Return to monitor
↑ P	Panic stop
U	Scale display Up by power of 2
D	Scale display Down by power of 2
E	Expand area between cursors
B	Negate all S commands - return original display.
S	Sum n bins before display
O	Negate all S commands - return Original display
Z	Return to unaltered display
A	Complement Axis - No axis switch
C	Complement Cursor - No cursor switch
V	Complement View bar graph or point plot display
↑ U	User Group I command

Group II   Commands; cannot be used during data collection

P	Plot the histogram being displayed
K	Calibrate the plotter
T	Type the data between the cursors
↑ B	Do a binary core image dump
↑ R	Retain the data, ready for restart
↑ I	User Group II command

APPENDIX

APPENDIX A

Schmitt Trigger

The Schmitt triggers on the LAB-8 are found on W5Ø1 modules. For circuit design, reference page 5-46 of the AXØ8 Maintenance Manual (DEC-Ø8-H6BA-D) available from Direct Mail, DEC, Maynard, Mass.

The Schmitt trigger circuit produces standard levels as a result of outside activity. The trigger will fire or not if it sees the input go through a negative seven tenths of a volt excursion and then cross a preset threshold. The threshold is set with the knobs to the left of the trigger inputs. If the knob is full counterclockwise, the threshold is set to -2.5 volts (signal must come from at least -1.8 volts before crossing the threshold to fire the trigger). If the knob is full clockwise, the threshold is set to -.5 volts (signal must come from at least +.2 volts before crossing the threshold to fire the trigger).

Time Constraints:

The negative seven tenths of a volt excursion, threshold crossing, and return crossing must take at least 5ØØ nanoseconds (this is the fastest excursion recognized by the circuitry). There is no upper limit on the slowest excursion recognized.

The maximum input voltage permissible is ±1Ø volts.

APPENDIX B

The BIN Loader is a program used to load the histogram programs and any core image dumps into memory. The BIN Loader tape is loaded by the RIM Loader. To load the BIN Loader, follow the procedure below. For loading RIM, see below

a. Put binary loader tape in reader (always put leader-trailer code over reader head, never blank tape).

b. Set SWITCH REGISTER (SR) to 7756_8 (the starting address of the RIM Loader).

c. Press LOAD ADD on computer console.

d. If using the low-speed (ASR-33) reader, turn the Teletype control knob to LINE and set the reader switch to START.

e. Depress the START switch on computer console. Tape should begin reading in. If not, check the RIM Loader and repeat steps a. to d.

f. After the program is read in, depress STOP switch on the computer console.

Read-in Mode (RIM) LOADER

The RIM Loader is a program used to load the Binary Loader. The RIM Loader must be toggled into memory using the switches on the computer console.

To load the RIM Loader, follow the procedure below for each location listed.

a. Set the SWITCH REGISTER to 7756.

b. Press LOAD ADD switch on the computer console.

c. Set the SWITCH REGISTER to the appropriate reader instruction value.

d. Press DEPOSIT switch.

e. Consider the next number in the table.

f. Return to Step C.

LOCATION	ASR33 READER	HIGH SPEED READER
7756	6Ø32	6Ø14
7757	6Ø31	6Ø11
776Ø	5357	5357
7761	6Ø36	6Ø16
7762	71Ø6	71Ø6
7763	7ØØ6	7ØØ6
7764	751Ø	751Ø
7765	5357	5374
7766	7ØØ6	7ØØ6
7767	6Ø31	6Ø11
777Ø	5367	5367
7771	6Ø34	6Ø16
7772	742Ø	742Ø
7773	3776	3776
7774	3376	3376
7775	5356	5357
7776	ØØØØ	ØØØØ

For more detailed information, refer to Introduction to Programming, Vol. 1.

APPENDIX C

Example of Parameter Setup

In the following example, the underlined portion of the dialog is generated by the program. The reply is not underlined.

1. Program started at location Ø2ØØ.

TRIGGER ↲	Check the Schmitt trigger thresholds. Carriage return tells the program this has been done.
PST? Y ↲	PST or Latency? PST chosen.
BINW= 5.Ø ↲	Bin width is set to 5.Ø milliseconds.
BINS= 1ØØ ↲	There are 1ØØ bins in the histogram.
EPOCHS= 4Ø ↲	There will be 4Ø stimulus - response sequences accepted.
MINTIM= Ø ↲	No minimum time constraints.

This dialog will produce a PST histogram. It will measure arrival times of responses from time zero (mintime = Ø) up to 5ØØ milliseconds (bin width x # of bins) with a resolution of 5 milliseconds following the stimulus. Forty stimulus response sequences will be accepted.

2.

PST? N ↲	Latency program desired.
ORDER= 5 ↲	The first five pulses following the stimulus should be recorded.
BINW= .5 ↲	1st answer was not in correct format. Question is reasked.
↲	
?BINW= Ø.5 ↲	Bin width is .5 milliseconds or 5ØØ μsec.
BINS= 19ØØ ↲	19ØØ bins exceeds the maximum allowable. User is notified of this and the question is reasked.
CORE? ↲	
BINS= 18ØØ ↲	18ØØ bins are requested and accepted by the program.

EPOCHS= 1ØØ ↓	Again the core limits are exceeded and the question is reasked.
CORE? ↓	
EPOCHS= 7Ø ↓	7Ø is accepted.
MINTIM= 1Ø ↓	Minimum time is 5 milliseconds (1Ø x .5).

Here a Latency histogram is requested. It will be a composit 5th order latency histogram (the histogram will be the frequency distribution of the first 5 pulses arriving following the stimulus). It will measure the time of arrival starting at 5 milliseconds after the stimulus (mintime = 1Ø X bin width) until 955 milliseconds after the stimulus (bin width X # bins + mintime) with a resolution of 5ØØ μsec. 7Ø stimulus response sequences will be accepted, before automatic transfer to output mode.

APPENDIX D

Implementation of User Commands

↑ U — Before utilization of either user command (↑ U or ↑ I), a listing should be consulted.

The user commands are designed to be patched in and will do anything that the user can program. ↑ U is a group I command and will be executed during data acquisition. To utilize ↑ U, change location 1352 from 124Ø to the location of the user routine. At the end of the user patch there should be a CLL CLA JMP I 121 (5521). This will return control to the main program.

↑ I — is a group II command to be executed only after data collection is finished. To implement ↑ I, change location 1353 from 124Ø to the location of the user routine. Again, at the end of the routine there should be a CLA CLL JMP I 121.

Note: The user patch for ↑ U must not turn the interrupt ON or OFF. It also must not disturb bits 2, 3, 4, 5 and 9 of the enable register of the AXØ8.

To find free areas of core, see a listing (available through DECUS).

APPENDIX E

Binary Output Format

When the ↑ B command is given a binary dump of the histogram being displayed will proceed on either the high or low speed punch. The dump will start with 64 leader trailer punches (these are channel 8 punches). For a description of paper tape punching format, see Introduction to Programming, Volume 1, 4-12.

After the first leader trailer punches, the ID code will be punched in ASCII format. This will be followed by more leader-trailer. The core image is proceeded by an address. This is signified by a 7 channel punch with the most significant 6 bits of the address on the same line followed by the least significant 6 bits on the next line. A core image follows the address.

The first core image is the display list. This gives the starting location -1 of 0th histogram followed by the ending address -1, followed by the starting address -1 of the 1st order histogram, followed by the ending address -1 of the 1st order histogram.

After the display list, the address of the histogram being dumped is punched followed by a core image of the histogram. After all information has been punched, a checksum is punched.

A checksum is a means of checking the validity of read-in. It is a 12-bit word which represents the sum of all of the punches in the tape that are not leader trailer or ASCII information. It is formed by adding every line of punched data (7 channels) to a 12 bit word. Overflows are ignored, and the resulting 12 bit sum is punched at the end of the data. This is followed by more leader trailer code.

When the binary loader reads the binary formatted tape, it keeps a running 12 bit sum of all punches between the end of the leader code and the checksum . (Note: the checksum punches are not included in the checksum.) If the result is non-zero, an error on read-in has occurred and the tape should be read-in again.

APPENDIX F

Attachment of an Analog X-Y Plotter

Plotting of a displayed waveform may be easily accomplished by the use of an analog plotter. Since the display is itself an analog device, the information carrying signal is available at the X and y input connections of the scope. The plotter should have an analog range of 0 to -10 volts.

To attach the plotter to the scope, simply run 2 wires from the plotter to the scope, inputs for each of the x and y connections and their respective grounds. The wires need not be shielded. Now, whatever voltage is available to the scope is also available to the plotter. To plot a waveform, one slow display cycle should be gone through.

Caution: While the display is running at its normal speed, the plotter should be disconnected or turned off because the pen will shake furiously attempting to follow the display.