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LARSON • DAVIS

MODEL 710
SOUND LEVEL METER
NOISE DOSIMETER

Definitions LEQ

Count on RMS Dist Report.

How can TWA1 be less than Minimum?
Levels below threshold drop 3dB every time doubling

ver. 2.0 © 1989

Table of Contents

See page 8

Appendix A

Appendix B

Appendix C

Introduction

LARSON•DAVIS has combined the latest microprocessor technology with an advanced analog instrumentation circuitry to produce a small, battery operated instrument without sacrificing features or operating accuracy. This manual has been written to help you use the features of the 710 to their fullest.

Seventeen Different Measurements

Designed for routine applications, the Model 710 provides two values of dose, projected dose, and time-weighted average (TWA) simultaneously. A third TWA is available with the L_{eq} function. The convenience of more than one dose at the push of a key allows the user to verify both of OSHA's requirements (80 dB and 90 dB threshold) with one measurement.

Measurements for Dose 1:

- Dose 1
- Projected Dose 1
- Time Weighted Avg 1

Measurements for Dose 2:

- Dose 2
- Projected Dose 2
- Time Weighted Avg 2

Measurements for Leq:

- Integrated Sound Level (L_{eq})
- Sound Exposure Level (SEL)

General measurements:

- Instantaneous Sound Pressure Level
- Maximum rms Level (L_{max})
- Minimum rms Level (L_{min})
- Peak Level, Unweighted
- Total Measurement Time
- Time over 115 dBA rms
- Time over 140 dBL peak
- Number of Overloads
- Battery Life in Percent

Measuring Accuracy

Ambient noise levels in the work place environment can range from very small to very large SPLs over short intervals of time. Noise impulses (caused by pneumatic tools, punch presses, steam valves, explosions, etc.) can instantaneously raise ambient noise levels to very high SPLs.

The dynamic range of a sound level meter is defined as a measure of the dB ratio between the largest and smallest measurable signal within a single range setting. Dynamic range is a key indication of the ability of an instrument to accurately respond to any changes in noise levels, regardless of how impulsive the noise is.

The 710 provides a full 110 dB dynamic range, which eliminates the need for range switches and prevents the loss or inaccurate measurement of data due to overload, under-range, or autorange errors. The dynamic impulse response is so advanced that the energy of a single 1 ms pulse can be accurately captured.

Architecture

A block diagram showing the major analog and digital sections of the Model 710 is shown in Figure 1.

Analog/Digital Features

The frequency response weighting implemented is A-weight. In addition to the Integrating RMS Detector, a separate Linear Peak Detector circuit with 40 dB dynamic range (nominally 113 to 153 dB) is provided to make detailed analysis of impulsive exposure possible.

The detected analog signals are converted to numeric form (as needed by the Digital Processor) by the Analog-to-Digital Convertor.

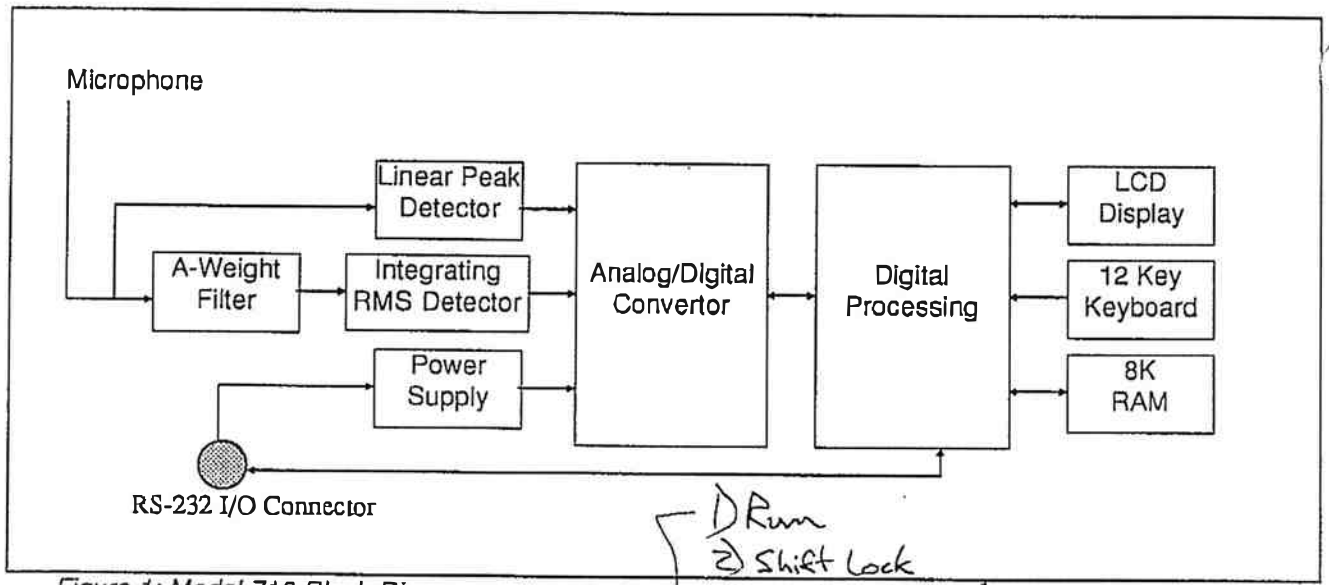


Figure 1: Model 710 Block Diagram

Annotated Display

LARSON·DAVIS designed a mistake-proof liquid crystal display for data readouts which shows the function key pressed along with the parameter value and proper units. Errors due to pushing the wrong button and misunderstanding what the display represents are virtually eliminated. For example, see Figure 2 which shows a "DOSE 2" value of 38.9% for measurement two.

Printer/Computer Interface

The 710 has an RS-232 port which allows downloading to a printer for a neatly formatted one-page report or to a computer for data filing and customized reporting.

Rugged Design

With its sealed keyboard and rugged case design, the 710 can perform well in harsh environments. Tested at very high and low temperatures and humidity, it is certified to hold its superb accuracies in extreme conditions.

All electronic circuits are completely enclosed with noise-reducing copper shields, which enable the 710 to measure very low sound pressure levels. The copper shields also minimize EMI and RFI radiation influences allowing its use in power plants and other high radiation areas. UL intrinsic safety certification is an option available.

1) Run
2) Shift Lock
3) enter 4 digits
4) push SLM or other key

Security

5) To unlock push 4 digits

Theft Protection

Embedded in the memory of each meter is the company name, the meter's serial number, and the software revision level. These are printed on all reports to identify product ownership and to deter theft or product misuse.

Locked Keyboard

See page 8

The 710 keyboard can be locked by pushing the "LOCK" key and entering 4 numbers. The keyboard will be inoperative until these same few numbers are again entered.

With the four lock numbers flashing the 710 will lock in the mode of the next key pressed and stay there until the lock sequence is entered.

Data Storage

Measured values are stored in virtual memory for several months or until the operator performs an intentional reset. Data will even survive low batteries and battery changes.

Many safeguards to prevent memory loss have been designed into the 710:

(1) The battery display label will flash when the battery is low; (2) the operator can check the battery's condition by pressing the BATT key; (3) a capacitor maintains RAM during battery change; and (4) the 710 automatically goes into the power-off state when a new battery is installed.

WARNING: Turning the 710 ON when the batteries are low or missing will cause measured data and customer entered parameters in RAM to be lost.

Pressing ON with the battery low or missing will cause the 710 to power up and discharge the capacitor before it can determine that there is not sufficient power to maintain RAM (random-access memory). When a good battery is installed, a "LOSS" message will be displayed indicating that RAM has been wiped out.

If the contents of RAM is lost, the 710 will default to the factory parameters found in ROM (read-only memory). Other parameters will have to be re-entered. Factory parameters are those requested by the customer at the time of purchase or those required by OSHA (Office of Safety and Health Administration)

Error Messages

NO.	ERROR MESSAGES
1	Dose Overflow Error
2	Count Overflow Error
3	Exponential Error
4	Report Print Format Error
5	Divide By Zero Error
6	Peak Entry Counter Overflow
7	History Memory Pointer Too Low
8	History Out Of Memory Error, Er – 8

Table 1: Error Messages

Occurs at Time 30:57
and stops the 710 until
Run is pressed – runs 1 minute + stops

Included Accessories

The following items are included with each Model 710 Dosimeter/Sound Level Meter:

- Adapter Cone that converts the dosimeter to a sound level meter.
- Phillips screwdriver for mounting adapter cone.
- Microphone windscreen.
- Microphone clip.
- Microphone holder for mounting microphone on the shoulder.
- Calibrator adapter for 3/8 in microphone.
- Calibration screwdriver.
- Carrying case (attaches to belt or strap).
- 9 V battery
- Operations Manual.

Model 710M

The 710M has all the features of the 710 plus the capability to store and print several thousand 1 min time history samples. Dual histogram tables showing distributed rms energy and distributed peak energy (impulses) above120 dB are standard.

Report compression features allow the user to compress the data history to 15, 30, 60 or 480 min time intervals. One special print mode allows the 710M to compress the time history data, regardless of the number of samples, to a single page report.

Notes:

Keys and Display Functions

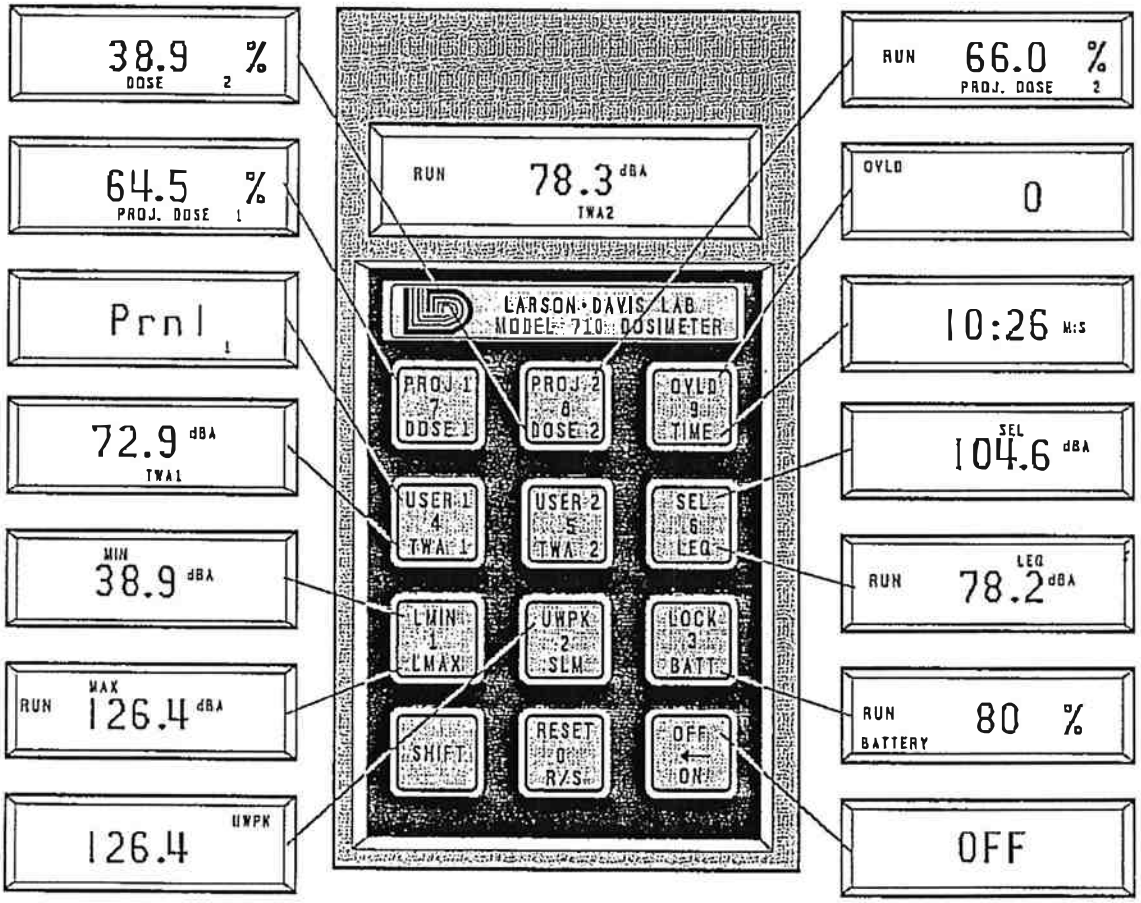


Figure 2: Model 710 Annotated Display

This chapter describes the keys and functions of the 710. Before taking and displaying data, install the 9 V battery by sliding the cover at the bottom and placing the battery into the clips provided.

Keys

Refer to Figure 2. The keys are dual function, with the primary key function on the bottom and color coded in white and the secondary key function on top and color coded in blue. Key functions coded in white are activated by directly pushing the key. Key functions coded in blue are activated as follows: (1) Press the SHIFT key; (2) remove the pressure from the SHIFT key; (3) press the desired blue-coded key. For example, to turn off the power, press the key labeled **SHIFT** then the key labeled **OFF**.

ON and OFF Functions

ON This key is pressed directly to turn on the power. The display will indicate that the instrument is "ON." The power on sequence takes a second to allow the analog circuitry to stabilize.

Note: If the keyboard has been locked, the ON key will turn on the power only long enough for the correct 4-number combination to be entered (see explanation of **LOCK** key).

When the unit is turned on, the validity of the memory is checked. If the voltage to the memory has dropped to a level below the safe memory retention level, the "LOSS" message appears. This message means that all the data has been lost. There is no way to recover lost data.

Note: Lost data will only occur if the battery is removed from the unit for several minutes or if the battery is allowed to become discharged.

OFF This key turns off the power. The display will show "OFF" until the key is released, then it will go blank.

The 710 must be stopped (**R/S** key) for the **OFF** key to work. When OFF, the power to all the analog circuitry is turned off, and the microprocessor circuit is put into a low power mode that monitors only the keyboard.

The power drain while OFF is significantly reduced and the battery will last for months. The memory, including all parameters and data, are maintained. In this low power mode the battery can be changed without losing parameters or data.

Note: The 710 has a special Auto-power Off feature where it will turn off if no key is pressed or if no I/O command is received within twelve minutes. The auto-off feature is enabled only when in the STOP mode. The 710 will also turn off when the battery becomes discharged (see explanation of BATT key).

and stop when memory is full (Er-8)
Runs 5 min. It will then run 1 min and stop again.

Measure and Display Functions

R/S (Run and Stop) Once the unit is on, press **R/S** and the display will go from "ON" to the last display mode previously used, and the word "RUN" will appear in the display. Only in the RUN mode are data taken and variables updated.

The data displays are available while in the RUN mode, but the print function is not allowed because it requires additional time that cannot be permitted under the tight timing constraints of the RUN mode. The OFF mode cannot be allowed because the taking of data could accidentally be halted.

When in the RUN mode, the run time clock is incremented every second. The elapsed run time can be seen by using the **TIME** key.

The STOP mode is the normal data examination mode. After the data has been taken and the data accumulation process stopped by the R/S key, the data can be examined and evaluated. It can also be printed as desired. No data are updated while in STOP except the display of the current battery level.

The labels on the various keys indicate the data that are displayed by that key. These are as follows:

TIME (Total Run Time) This function provides the total run time that data has been taken. It initially reads in minutes : seconds and then changes to hours : minutes. Periods in which the unit was stopped are not counted.

OVLD (Overloads) This key displays the number of times the level has exceeded the 710's measurement range. When an overload occurs, there is a possibility that the various measurement parameters such as Dose, TWA, LMAX, and UWPK may read low and, therefore, may need repeating.

SLM (Sound Level Meter) This key displays the current sound pressure level (SPL) in numeric form. As you speak you can observe the level change as controlled by the SLOW detector. All measured levels are displayed in decibels as indicated by the "dB" characters, and the frequency response weighting is shown with an "A."

Note: DOSE 1, PROJ 1, & TWA 1 are calculated on the criteria level, threshold, and exchange rate listed for measurement 1 parameters. DOSE 2, PROJ 2, & TWA 2 are calculated for measurement 2 parameters. The exchange rate, criteria level, and threshold values for Dose, TWA, and Threshold are given default settings at the factory. However, these settings can be changed from the 710 keyboard or from a computer.

DOSE (Acoustic Dose) This key displays the current dose that has been accumulated for the time shown, based on an eight hour exposure to the criteria level.

Dose is a measure of allowable noise exposure. It is based on a time period of eight hours and three parameters: Criterion Level, Threshold Level, and Exchange Rate. A dose of 100% is equivalent to an exposure at the Criterion Level for 8 hours. Only levels above the threshold are considered in the dose calculations. For this reason, the TWA may not indicate any value if this threshold is not exceeded.

PROJ (Projected Dose) Projected Dose provides the estimated eight hour dose as based on the current exposure and elapsed time. This function allows a quick assessment of the exposure that will occur in an area, provided the pattern of noise exposure remains consistent.

PROJ = DOSE X (8/T)

T = elapsed time in hours. The elapsed run time can be obtained by pressing the key labeled **TIME**.

TWA (Time Weighted Average) This key provides the time weighted average level as calculated from the measurement parameters placed by the factory into the memory of the 710. For example, the measurements labeled "1" might be a 90 dB criterion level, a 80 dB threshold, and a 5 dB exchange rate.

The Time Weighted Average gives the same value as a steady sound at the same level for the elapsed period of time. Only sound above the threshold is used in the calculation.

For noise that changes over a period of time, the level is related to an exchange rate that is selected from the following:

L_{eq}	3 dB
L_{DOD}	4 dB
L_{OSHA}	5 dB
L_{avg}	6 dB

SEL (Sound Exposure Level) The sound exposure level for 1 s is equivalent to the average sound level for the total run time. This key uses the 3dB rule (equal energy) without any threshold.

SEL = 10 log (T) + Leq

T = run time in seconds
Leq = average sound level.

LEQ This key provides the integrated level (Time Weighted Average) using the 3dB rule (equal energy) without any threshold.

LMIN (Minimum Level) This key displays the minimum level measured with slow response during the time that the unit was running.

UWPK (Unweighted Peak) This key displays the maximum level of the unweighted peak during the time the unit was running. There is a separate circuit with a 40 dB range for this measurement. This means the noise floor is typically from 105 to 114 dB.

LMAX (Maximum Level) This key displays the maximum level measured with slow response during the time that the unit was running.

Printing Functions

USER 1 To print a one page standard report to any serial printer, connect the 710 to the printer with the appropriate printer cable and press the **USER 1** key. See Appendix A for a sample report and Appendix C for the communications specifications.

USER 2 The Model 710 can be customized so that special and time history reports are available. These reports are obtained by pressing **USER 2** and a numbered key from 0 to 9. Each number will cause the 710 to print a report associated with that number. In Ap-

pendix B is a list of the special reports available for your particular unit. See Appendix C for the communications specifications.

Auxillary Functions

Warning: Pressing the RESET key will cause the loss of all stored data.

RESET (Clear Data From Memory) The display will start to count down from 5 s to 0 (1 s to 0 is an option) in 0.1 s increments. Pushing any key before the countdown reaches 0 cancels the reset. When 0 is displayed, the memory of the 710 is reset.

BATT The expected battery life is greater than forty hours at room temperature. This key displays the approximate percentage of battery life left. A new battery will generally read above 94.

At a battery level of 2 a flashing "BATTERY" message will appear. This message will also be displayed when the unit is turned back on after a discharged battery has caused the unit to turn off. The flashing "BATTERY" will turn off after a reset or when the **BATT** key is pressed. The battery should be replaced, but there is sufficient energy remaining in the battery so that data will still be preserved for several days if left OFF

At 0% the unit will automatically stop and turn off.

LOCK The 710 keyboard can be locked by pressing the **LOCK** key and entering 4 numbers.

Warning: You must remember the four numbers! RS232 and R2S

While the keyboard is locked, the display shown is determined by the key pressed immediately after the 4 numbers are entered. If no display is desired, press the R/S key.

To unlock the 710, press the 4 number sequence that made up the combination. (Note: If the unit is off, press the ON key ~~first~~). and RUN

cc JCorey 4-18-94

Customized Functions (ver. 2.0+)

Parameter Modification Function

Nine parameters may be viewed and modified.

- **Viewing Parameters:** with 710 on

1. Press and hold **SHIFT**.
2. Press and hold **ON**.
3. Release **SHIFT** (optional).
4. Wait 5 s.
5. When the display shows "Pn=0," release ON.

   Pn indicates "parameter number." The "0" flashes to prompt for the insertion of the desired parameter number.
6. Enter the desired parameter number. See Table 1 for the numbers 1 to 9 representing the parameters.

After the parameter number is entered, a character representing the parameter name is displayed with the current value (see Table 1). All of the parameters with their values are also shown on the USER 1 Data Report.

Pressing **SHIFT** once will recall the Pn prompt and pressing **SHIFT** twice will return the 710 to its normal function.

- **Modifying Parameters:**

The 710 must first be reset before parameters can be modified. See "RESET" under "Auxillary Functions." After the RESET, proceed as explained under "Viewing Parameters." Then enter the new value as prompted by the flashing digits. To complete entering the value, the digits must stop flashing.

The minimum and maximum values that can be entered are shown in Table 1. The ← (back arrow) key can be used to correct entry errors.

Moving the back arrow out of the entry field will recall the Pn prompt. Pressing the back arrow key once more will return the 710 to its normal function.

Regardless of which entry digit is flashing pressing **SHIFT** once will recall the Pn prompt and pressing **SHIFT** twice will return the 710 to its normal function.

When the new value is entered, it is checked to make certain it is within range. If it is correct, the Pn prompt

will be recalled. If it is not correct, "Er-A" is displayed, meaning Error-A, "Parameter Entered Wrong." Press SHIFT once and start again.

Pn	PARAMETER	RANGE	VALUE	
1	Criterion #1	0-200	Cnnn	1
2	Threshold Level #1	0-200	Lnnn	1
3	Exchange Rate #1	3-6	E n	1
4	Criterion #2	0-200	Cnnn	2
5	Threshold Level #2	0-200	Lnnn	2
6	Exchange Rate #2	3-6	E n	2
7	RMS Excd Level	70-200	Rnnn	
8	Peak Excd Level	100-200	Pnnn	
9	Excd Hysteresis	1-8	H n	

Explanation of headings:

Pn	Parameter number
Range	Minimum and maximum values that can be entered
Value	Character representing the parameter followed by the currently entered value.

Table 2: Modifiable Parameters

New Display Function

- **Serial Number**

  The serial number may be viewed from the keyboard by holding the **ON** key down for 3 s.

- **Display Test**

  Holding down the BATT (battery) key for 5 s will verify that all display labels are functioning correctly. A code indicating the firmware type will also appear.

1-C:F

5-21-91

1-5:F.-

V2.518 06 Dec 1989

"R23 Enter"

1-C:F.-

V2.520 25 Feb 91

Notes:

Calibration

When to Calibrate

The calibration pot at the back of the 710 is active at all times, so after a set of measurements, it is a good practice to check the sound level of the 710 with a calibrator. As long as the level read out by the 710 is within ±2 dB of the known source, it is suggested that no adjustments to the cal pot be made. If large fluctuations in the level start occurring (more than ±1 dB), either the calibrator or the 710 may have a problem. One common problem that can occur is that a raindrop has hit the microphone, causing a few dB loss of sensitivity for a day or so until the microphone dries out. In this case, calibration will not be of any use as the response of the microphone will change as it dries out. A better approach is to let the 710 set for a day and then recheck the level. If it stays the same, then perhaps the cal pot was changed. If the level moved, then perhaps the microphone is drying out or a more serious problem is occurring. In any case, recalibrating the instrument should occur only when the level has stabilized.

Procedure Using the CA250,

The microphone should be placed in the 3/8 in adapter so that a seal occurs, and the CA250 is turned on.

- **A-weighted Level at 250 Hz**

With the 710 in the SLM mode and in run, the level read should be 105.4 dB. The level of 105.4 dB is obtained by subtracting 8.6 dB from 114 dB. The 8.6 dB is the correction for the A-weighted level at 250 Hz.

- **A-weighted Level at 1000 Hz**

If a 1000 Hz calibrator is used, then the level indicated on the calibrator can be used since there is no correction for A-weighting at 1000 Hz.

- **Calibration Adjustment**

If the SLM reading is correct, no adjusting of the cal pot is necessary. If the cal pot requires adjusting, simply move the pot clockwise to raise the level or counter clockwise to lower the level. When the level reads exactly 105.4 dB ±0.2 dB, observe the reading for a few seconds to insure that the unit is stabilized. Then stop the unit, reset the data, and the unit is ready to take data as soon as the run key is pressed.

- **Print Out**

A written record of calibration can be obtained by resetting the data, placing the microphone in the sound source, and running and stopping the 710 for a few seconds. Use USER 1 to print out a report. The annotated printout will provide a record of the calibration.

Notes:

Specifications

Acoustical and Electrical

Dynamic Range
110 dB min., 35 to 145 dBA in one range

Crest Factor
40 dB (based on 1 sec rms integration)

Pulse Range
80 dB min. using 1 msec burst of 4 kHz

Single Pulse Response
less than 1.5 dB error for a single cycle of 1 kHz at 140 dB

Noise Floors
35 dB max. A-weight slow 105 to 114 dB flat weighted peak

Frequency Response
A-weight meets ANSI S1.4 1983

Peak Detector Flat
11 Hz to 10 kHz

Detector Accuracy 10 Samp./sec
True rms, less than 0.4 dB error from 40 to 140 dB
50–100 μSec Type I faster

Display
Custom 16 element LCD 0.1 dB, 0.1% resolution

Power Supply
9 V Alkaline Battery Duracell MN1604 or equivalent

External Supply: 7 to 16 V dc at 18 mA max.

Operating Time
40 hr continuous, 3 mo memory retention
33 with alkaline 15mA @ 500mAH
~~28~~ with carbon zinc (3/4) @ 429 mAH (Panasonic)

Standards Met

ANSI S1.4 1983 Type 2

IEC 651 Type 2

IEC 804 Type 2

Environmental

Effect of Humidity
Less than 0.5 dB error with 90% humidity at 25 °C (72 °F)

Effect of Temperature
Less than 0.5 dB error from -20 to 50 °C

Storage Temperature Range
-30 to 60 °C

Effect of Magnetic Fields
47 dB (A or C weight) @ 80 A/M (1 Orsted) and 67 dBA @ 800 A/M
(10 Orsted)

Memory Saturation

Elapsed Time
19.4 days @ 140dB
1 min LEQ 8K RAM

Dose
19999%

TWA
limited to 19.4 days

64K memory 710C 256K mem

Projected Dose
9999%

Number of Overloads
255

3900 minutes
~~28~~ 24 Days then stop

Number of Stops

255

Overload Level

145 dB min.

SPL

140 dB min.

Peak

145 dB min.

Physical

Dimensions

Width: 7.5 cm (3 in)

Length: 15.0 cm (6 in)

Depth: 2.5 cm (1 in)

Weight

326 g (11.5 oz)

Warranty

LARSON-DAVIS Laboratories, Inc. (Larson-Davis) warrants this product against defects in material and workmanship for a period of two years from the original date of purchase. This warranty applies only to products and components supplied by Larson-Davis which can be identified by the trade name or logo affixed to them or other documents. Larson-Davis does not warrant any products not supplied by Larson-Davis.

During the first year of the warranty period, Larson-Davis will repair (or at its option replace) any defective component(s) without charge for parts or labor, provided the unit is returned freight prepaid, to an authorized Larson-Davis Service Center. The unit will be returned freight prepaid.

During the second year of the warranty period, Larson-Davis will repair (or replace) any defective component(s) without charge for parts, provided the unit is returned freight prepaid, to an authorized Larson-Davis Service Center. Labor and return freight charges are not covered.

In order to obtain warranty or non-warranty service, obtain the name and address of the nearest authorized Larson-Davis Service Center from your local Larson-Davis Representative or from Larson-Davis directly. Attach to the unit your name, address, phone number, description of the problem and date purchased.

This warranty does not apply if the product has been damaged by accident, abuse, misuse or misapplication, or as a result of service or modification by other than an authorized Larson-Davis Service Center, nor are any other warranties expressed or implied, including any regarding merchantability or fitness for a particular purpose.

Larson-Davis is not responsible for incidental or consequential damages resulting from the breach of any express or implied warranty, including damage to property and, to the extent permitted by law, damages for personal injury. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Appendix A

Notes:

Need Same Data base for all Printouts

User 1 Printout

Figure A-1 shows a typical summary Data Report and Peak Distribution Table printout of the 710. The parameters listed for Dose 1 and Dose 2 are not necessarily those set into your EPROM. You can make a printout to see your values of these parameters.

The following four notes explain some of the features of the summary Data Report printout.

Note 1 The time and date of the measurement can be annotated here. Both a start time and an end time are useful.

Note 2 The run time is in hours:minutes:seconds. The seconds are to the nearest 1/10 s.

Note 3 The 710 samples at a rate of 10/s. These lines indicate the number of events at or over the thresholds indicated. The time given is calculated by multiplying the number of samples above threshold by 0.1 s. When an event occurs, a second event cannot occur until the level drops a certain number of decibels below the threshold. This number of decibels is called hysterisis. For example, with a hysterisis of 2, a level that rose to a rms level of 116 dB, then dropped to 114 dB, and then rose to 117 dB would be considered only one event.

Note 4 As described in note 3, the Hysterisis is the value that is subtracted from the exceedance or peak threshold to determine when an exceedance event should end. Hysterisis prevents the problem of a level that fluctuates around the threshold causing a large number of events.

(The Peak Distribution table is available only with the 710M unless specially ordered. Notes 5, 6, and 7 apply only to this table.)

Note 5 The Peak Distribution table provides a listing the number of times a particular peak level occurred from 120 dB to 140 dB. This peak level is the highest peak each 1/10 s or 1 s as ordered from the factory. In the sample, the unit was on 5 min, 14 min, and 43.5 s. There were 183,617 peaks, 183 thousand of which were below 120 dB, 6 at 137 dB, and 21 over 140 dB.

Note 6 The Summation of Acoustical Energy (SAE) is the energy sum of the 1 s peak levels.

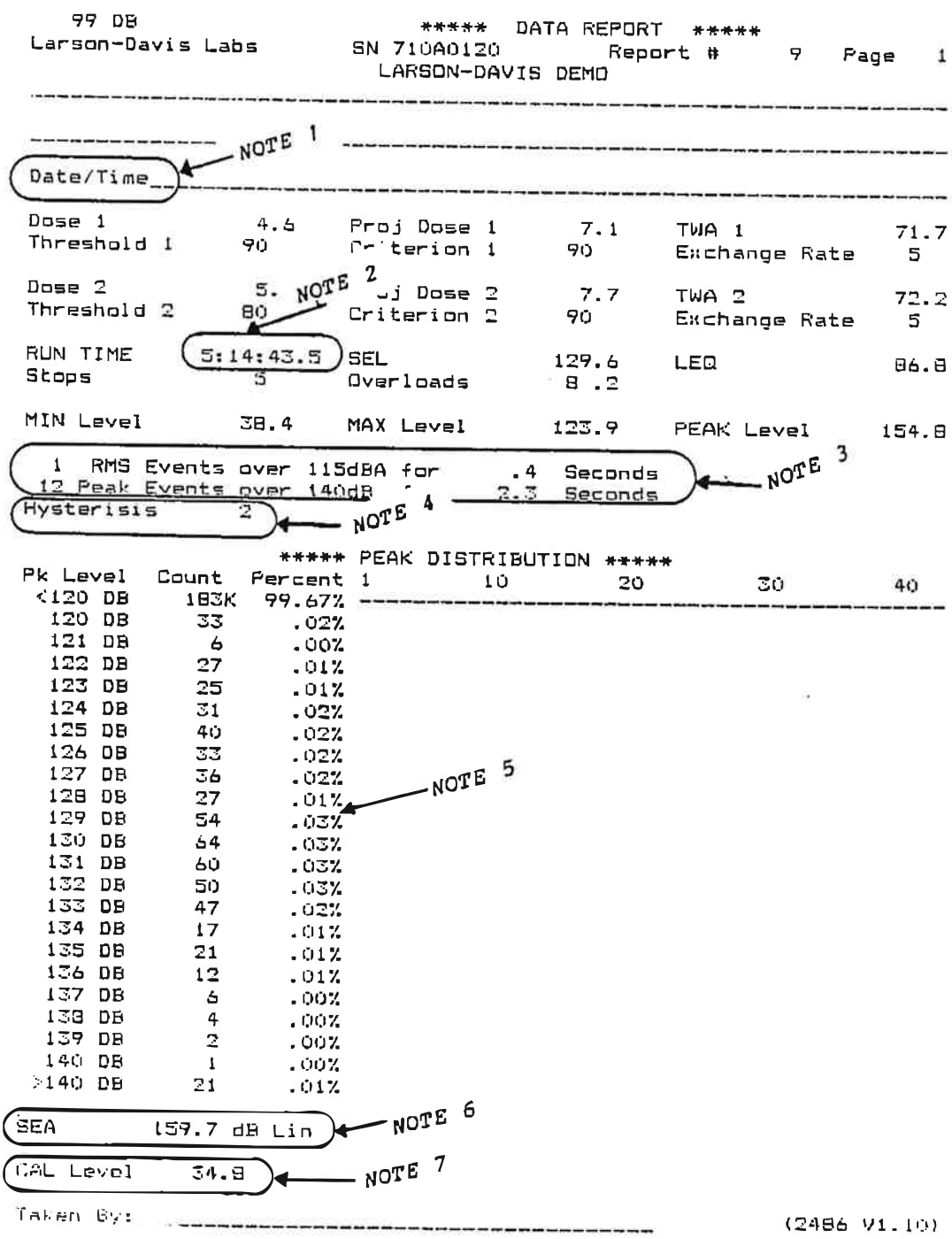
The formula is as follows:

$$SEA = 10 \log \sum_{1} (C_i 10^{Pi/10}) \cdots$$

C = Count, number of peaks
P = Peak Level
The SEA for the example is calculated as follows:

$$SEA = 10 \log (33x10^{12.0} + 6x10^{12.1} \ldots + 21x10^{14.0}) = 159.7$$

Note 7 The CAL level should stay constant from report to report unless the cal pot has been changed. If the cal pot was tampered with during a measurement, it will show up as a change. It is a good practice to check this level after each measurement is printed out.



```
   99 DB                          ***** DATA REPORT *****
Larson-Davis Labs              SN 710A0120        Report #     9   Page   1
                                 LARSON-DAVIS DEMO
-------------------------------------------------------------------------------
-------------- NOTE 1 ----------------------------------------------------------
Date/Time_____________________________________________________________________

Dose 1              4.6    Proj Dose 1          7.1    TWA 1              71.7
Threshold 1         90     Criterion 1          90     Exchange Rate      5

Dose 2              5.  NOTE 2  Proj Dose 2      7.7    TWA 2              72.2
Threshold 2         80     Criterion 2          90     Exchange Rate      5

RUN TIME        5:14:43.5  SEL                 129.6   LEQ                86.8
Stops               5      Overloads            8 .2

MIN Level           38.4   MAX Level           123.9   PEAK Level         154.8

  1  RMS Events over 115dBA for      .4  Seconds   NOTE 3
 12 Peak Events over 140dB        2.3  Seconds
Hysterisis          2   NOTE 4

                    ***** PEAK DISTRIBUTION *****
Pk Level   Count   Percent  1         10         20         30         40
 <120 DB    183K   99.67%  ----------------------------------------
  120 DB      33     .02%
  121 DB       6     .00%
  122 DB      27     .01%
  123 DB      25     .01%
  124 DB      31     .02%
  125 DB      40     .02%
  126 DB      33     .02%
  127 DB      36     .02%
  128 DB      27     .01%   NOTE 5
  129 DB      54     .03%
  130 DB      54     .03%
  131 DB      60     .03%
  132 DB      50     .03%
  133 DB      47     .02%
  134 DB      17     .01%
  135 DB      21     .01%
  136 DB      12     .01%
  137 DB       6     .00%
  138 DB       4     .00%
  139 DB       2     .00%
  140 DB       1     .00%
 >140 DB      21     .01%

SEA          159.7 dB Lin   NOTE 6
CAL Level    34.8           NOTE 7

Taken By: _____________________________                    (2486 V1.10)
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Figure A-1: Data Report and Peak Distribution Table

Appendix B

Notes:

User 2 Printouts

Ten distinct history formats that can be obtained by use of the USER 2 function. These are accessed by pressing "USER 2" and one of the 0 to 9 keys. Each digit provides a unique report as follows:

0 This provides four reports automatically as shown in Figures B-1, B-2, and B-3. These reports are a summary Data Report, Peak Distribution Table, RMS Distribution Report, and History Report. The History Report is compressed to fit on one page.

1 This provides the complete history report of all samples.

2 This provides a history report that has been compressed by a factor of 6: the history samples are grouped in sets of 6, and the time weighted average of each set is calculated.

3 This provides a history report that has been compressed by a factor of 15: the history samples are grouped in sets of 15, and the time weighted average of each set is calculated. See Figure B-4.

4 This provides a history report that has been compressed by a factor of 30: the history samples are grouped in sets of 30, and the time weighted average of each set is calculated. See Figure B-5.

5 This provides a history report that has been compressed by a factor of 60: the history samples are grouped in sets of 60, and the time weighted average of each set is calculated. When the sample length is 1 min, this report provides hourly TWAs. See Figure B-6.

6 This provides a history report that has been compressed by a factor of 240: the history samples are grouped in sets of 240, and the time weighted average of each set is calculated. See Figure B-7.

7 This provides a history report that has been compressed by a factor of 480: the history samples are grouped in sets of 480, and the time weighted average of each set is calculated. See Figure B-8.

8 This provides a history report of samples compressed by the amount required so they fit on one page. See Figure B-3.

9 This provides a RMS distribution of all samples. See Figure B-2.

NOTES:

1. To obtain a summary Data Report alone, use USER 1 key.

2. For the RMS Distribution, the 710 samples at a rate of 10 times a second. The number of counts will be ten times the number of seconds at each level.

3. An additional use of the model 710M is to take multiple samples, using a stop after each measurement. The report is then printed out with a large compression factor so that the TWA of each measurement is provided. See Figure B-9. The only caution in using this procedure is to recognize that in time history, the last data sample before a stop will probably not be a full sample length. When this value is combined with other samples for compression, it is treated as if it were a full sample. The error caused by this will normally be negligible unless the sound level of the last sample is much greater then the previous samples.

```
                        ***** DATA REPORT *****
Larson-Davis Labs          SN 710A0134          Report #     1    Page    1
                      <30-CHAR CUSTOM COMPANY NAME>
-------------------------------------------------------------------------

-------------------------------------------------------------------------

Date/Time______________________________________________________________

Dose 1            14.2     Proj Dose 1       14.2     TWA 1            76.3
Threshold 1       90       Criterion 1       90       Exchange Rate     5

Dose 2            14.4     Proj Dose 2       14.4     TWA 2            76.4
Threshold 2       80       Criterion 2       90       Exchange Rate     5

RUN TIME       7:58:04.2   SEL              131.8     LEQ              87.2
Stops              1       Overloads          8 .1

MIN Level         32.9     MAX Level        119.1     PEAK Level       147.1

  5  RMS Events over 115dBA for     1.4  Seconds
 11 Peak Events over 140dB  for     2.0  Seconds
Hysterisis        2

                      ***** PEAK DISTRIBUTION *****
Pk Level   Count   Percent 1         10         20         30         40
 <120 DB    279K  99.85% ----------------------------------------
  120 DB      16     .01%
  121 DB      25     .01%
  122 DB      18     .01%
  123 DB      24     .01%
  124 DB      20     .01%
  125 DB      40     .01%
  126 DB      28     .01%
  127 DB      22     .01%
  128 DB      24     .01%
  129 DB      29     .01%
  130 DB      28     .01%
  131 DB      40     .01%
  132 DB      16     .01%
  133 DB      16     .01%
  134 DB      12     .00%
  135 DB      16     .01%
  136 DB      16     .01%
  137 DB      20     .01%
  138 DB       9     .00%
  139 DB       6     .00%
  140 DB       4     .00%
 >140 DB      15     .01%

SEA         159.1 dB Lin

CAL Level    28.4

Taken By: ____________________________________          (2486 V1.10)
```

Count = 10X seconds

Figure B-1: Data Report and Peak Distribution Table

Samples 10 times/second

```
          ***** RMS DISTRIBUTION REPORT*****
Larson-Davis Labs        SN 710A0134          Report #      1    Page    2
Level       Count  Percent 1         10         20         30         40

<= 36 DB    20092     7.00% *******
   37 DB      476      .17%
   38 DB      693      .24%
   39 DB    27217     9.49% *********
   40 DB    59118    20.61% **********************
   41 DB    20940     7.30% *******
   42 DB     8321     2.90% ***
   43 DB     5790     2.02% **
   44 DB     4870     1.70% **
   45 DB     4820     1.68% **
   46 DB     4390     1.53% **
   47 DB     6760     2.36% **
   48 DB     9888     3.45% ***
   49 DB     6950     2.42% **
   50 DB     5810     2.03% **
   51 DB     5321     1.86% **
   52 DB     5214     1.82% **
   53 DB     5367     1.87% **
   54 DB     5455     1.90% **
   55 DB     5455     1.90% **
   56 DB     5373     1.87% **
   57 DB     5298     1.85% **
   58 DB     5108     1.78% **
   59 DB     4879     1.70% **
   60 DB     4977     1.74% **
   61 DB     4651     1.62% **
   62 DB     4391     1.53% **
   63 DB     3928     1.37% *
   64 DB     3795     1.32% *
   65 DB     3387     1.18% *
   66 DB     3282     1.14% *
   67 DB     2964     1.03% *
   68 DB     2572      .90% *
   69 DB     2203      .77% *
   70 DB     1804      .63% *
   71 DB     1524      .53% *
   72 DB     1074      .37%
   73 DB      776      .27%
   74 DB      606      .21%
   75 DB      436      .15%
   76 DB      404      .14%
   77 DB      350      .12%
   78 DB      295      .10%
   79 DB      269      .09%
   80 DB      251      .09%
   81 DB      227      .08%
   82 DB      199      .07%
   83 DB      163      .06%
   84 DB      177      .06%
   85 DB      146      .05%
   86 DB      142      .05%
   87 DB      139      .05%
```

Count = 10X seconds at each level. (pg 21)

Figure B-2: RMS Distribution Report

```
          ***** RMS DISTRIBUTION REPORT*****
Larson-Davis Labs        SN 710A0134        Report #     1    Page   3
Level      Count   Percent 1         10         20         30         40

   88 DB     127      .04%
   89 DB     121      .04%
   90 DB     117      .04%
   91 DB     109      .04%
   92 DB     119      .04%
   93 DB     117      .04%
   94 DB     115      .04%
   95 DB     126      .04%
   96 DB     118      .04%
   97 DB     120      .04%
   98 DB     123      .04%
   99 DB     132      .05%
  100 DB     139      .05%
  101 DB     158      .06%
  102 DB     190      .07%
  103 DB    5410     1.89% **
  104 DB      91      .03%
  105 DB      80      .03%
  106 DB      83      .03%
  107 DB      63      .02%
  108 DB      60      .02%
  109 DB      65      .02%
  110 DB      62      .02%
  111 DB      72      .03%
  112 DB      38      .01%
  113 DB      35      .01%
  114 DB      20      .01%
  115 DB      17      .01%
  116 DB      17      .01%
  117 DB      18      .01%
  118 DB      22      .01%
  119 DB      12      .00%
  120 DB       5      .00%
  121 DB       4      .00%
  122 DB       0      .00%
  123 DB       0      .00%
  124 DB       0      .00%
  125 DB       0      .00%
  126 DB       0      .00%
  127 DB       0      .00%
  128 DB       0      .00%
  129 DB       0      .00%
  130 DB       0      .00%
  131 DB       0      .00%
  132 DB       0      .00%
  133 DB       0      .00%
  134 DB       0      .00%
  135 DB       0      .00%
  136 DB       0      .00%
  137 DB       0      .00%
  138 DB       0      .00%
  139 DB       0      .00%
=>140 DB       0      .00%
```

Figure B-2 (continued): RMS Distribution Report

```
                    ***** HISTORY REPORT*****
Larson-Davis Labs        SN 710A0134        Report #      1   Page   4
Threshold  0       Exchange Rate  3       Period  60      Cond. by   10

Count     Level
   10      87.9  **************************
   20      79.1  ***********************
   30      86.0  *************************
   40      84.8  ************************
   50      83.6  ************************
   60      85.6  *************************
   70      59.5  ************
   80      87.6  *************************
   90      63.5  ***************
  100      80.1  ***********************
  110      40.4  **
  120      80.6  ***********************
  130      86.4  *************************
  140      60.3  ************
  150      59.8  ************
  160      91.0  ****************************
  170      39.9  **
  180      39.8  **
  190      39.9  **
  200      39.8  **
  210      40.1  **
  220      40.4  **
  230      77.6  ********************
  240      90.0  ****************************
  250      56.9  **********
  260      56.1  **********
  270      46.0  *****
  280      41.5  ***
  290      40.6  **
  300      54.3  *********
  310      57.6  ************
  320      58.4  ************
  330      55.5  ***********
  340      60.8  *************
  350      60.8  *************
  360      66.2  ****************
  370      60.4  *************
  380      57.9  ***********
  390      64.8  ***************
  400      66.9  ****************
  410      51.9  ********
  420      65.3  ***************
  430      94.5  ******************************
  440      65.6  ****************
  450      55.2  **********
  460      94.4  ******************************
  470      99.1  *******************************
  479      99.6  ********************************
  480     STOP   1
```

count 2550 max

Figure B-3: History Report Compressed to One Page

```
                    ***** HISTORY REPORT*****
Larson-Davis Labs        SN 710A0134          Report #     1    Page    1
Threshold   0       Exchange Rate  3       Period   60      Cond. by    15

Count     Level
   15      86.2  ************************
   30      85.1  ************************
   45      83.1  ***********************
   60      86.0  ************************
   75      83.6  ************************
   90      82.0  ***********************
  105      78.3  *********************
  120      78.9  *********************
  135      84.8  ************************
  150      58.6  ***********
  165      89.3  *************************
  180      39.9  **
  195      39.9  **
  210      39.9  **
  225      40.6  **
  240      88.5  *************************
  255      57.3  **********
  270      49.8  *******
  285      41.1  **
  300      52.6  ********
  315      58.3  ***********
  330      56.1  **********
  345      60.1  ************
  360      65.3  **************
  375      59.9  ************
  390      63.4  *************
  405      65.3  **************
  420      63.6  **************
  435      92.8  ****************************
  450      56.3  **********
  465      94.9  *****************************
  479     100.2  ********************************
  480     STOP   1
```

Figure B-4: History Report Compressed Factor of 15

```
                    ***** HISTORY REPORT*****
Larson-Davis Labs       SN 710A0134        Report #     1   Page   1
Threshold  0      Exchange Rate  3      Period  60     Cond. by   30

Count     Level
   30      85.7  ************************
   60      84.8  ************************
   90      82.9  ***********************
  120      78.6  ******************
  150      81.8  ************************
  180      86.3  *************************
  210      39.9  **
  240      85.5  ************************
  270      54.9  *********
  300      49.9  *******
  330      57.3  **********
  360      63.4  ************
  390      61.9  ************
  420      64.5  ************
  450      89.8  ****************************
  479      98.3  ********************************
  480     STOP   1
```

Figure B-5: History Report Compressed Factor of 30

```
                    ***** HISTORY REPORT*****
Larson-Davis Labs       SN 710A0134        Report #     1   Page   1
Threshold  0      Exchange Rate  3      Period  60     Cond. by   60

Count     Level
   60      85.3  ***********************
  120      81.3  ********************
  180      84.5  ************************
  240      82.5  ************************
  300      53.1  *******
  360      61.4  ***********
  420      63.4  ************
  479      95.8  ********************************
  480     STOP   1
```

FIG. B-6

Figure B-6: History Report Compressed Factor of 60

```
                    **** HISTORY REPORT****
Larson-Davis Labs        SN 710A0134        Report #     1   Page   1
Threshold  0       Exchange Rate  3      Period  60     Cond. by  240

Count     Level
  240      83.7  **********************
  479      89.6  ************************
  480     STOP   1
```

Figure B-7: History Report Compressed Factor of 240

```
                    **** HISTORY REPORT****
Larson-Davis Labs        SN 710A0134        Report #     1   Page   1
Threshold  0       Exchange Rate  3      Period  60     Cond. by  480

Count     Level
  479      87.6  ***********************
  480     STOP   1
```

Figure B-8 History Report Compressed Factor of 480

```
                    ***** HISTORY REPORT*****
Larson-Davis Labs        SN 710A0100        Report #     1   Page   1
Threshold  0       Exchange Rate  3      Period  60     Cond. by  480

Count     Level
    3      70.4  ****************
    4     STOP   1
  484      93.1  ****************************
  516      60.2  ************
  517     STOP   2
```

Figure B-9: History Report Compressed to Provide TWA

Appendix C

Notes:

Bidirectional Control

Bidirectional control through an RS-232 port enables computers to send commands to and receive data from the 710.

CABLE NO.	DEVICE	DEVICE CONNECTION
710-C01	Serial Printer	Male 25-pin D
710-C04	Other	None, open wires
710-C06	Ext. Battery	Alligator Clips
710-C10A	Computer w/	Male 25-pin D (with level converor)
710-C10B	IBM PC™	Female 25-pin D (with level convertor)
710-C10C	IBM PC-AT™	Female 9-pin D (with level Convertor)

Note: Unless otherwise noted, the connector refers to an RS-232 plug. "IBM"™ includes compatibles.

Table C-1: LARSON•DAVIS Cables

MODEL 710 Pin	Function	25-PIN RS-232 Pin	Function	9-PIN RS-232 Pin	Function
1	Ground	7	Signal Grnd	5	Signal Grnd
2	TXD	3	RXD	2	RD
3	RXD/CTS	2	TXD	3	SD
4	External Pwr	No Connection		No Connection	
5	DTR	No Connection		No Connection	

The meanings of the abbreviations are as follows:

TXD:	Transmitted Data	(output)
RXD:	Received Data	(input)
CTS:	Clear to Send	(input)
DTR:	Data Terminal Ready	(output)
RD:	Received Data	(input)
SD:	Send Data	(output)

Table C-2: Pin Functions

Connection to an External Device

For connection to an external device, the 710 has a 5-pin Switchcraft connection next to the battery cover. To connect the 710 to a specific device such as a computer, printer, or battery requires a specific cable. Table C-1 lists the cables that can be obtained from LARSON•DAVIS and Table C-2 lists the pin functions.

Communications Specifications

Communications specifications are as follows:

Baud Rate:	1200
Data Bits:	8
Parity:	None
Stop Bits:	1 or 2

RS-232 Commands

The six commands are Mode, Query, Read, Data, Set, and Print Report. Commands are sent as ASCII character strings under the following rules:

1. The 710 cannot collect data and communicate with a computer at the same time.
2. Command strings have a limit of 4 characters including spaces but not including the carriage return or optional linefeed.
3. The first character is a letter representing the command. Example: R for Read
4. The next 1 to 3 characters are numerals or spaces representing the option. Example: R 21 or R21 for Read Unit Name
5. The command string is ended by a carriage return (ASCII 13_{10}, $0D_{16}$) and an optional linefeed (ASCII 10_{10}, $0A_{16}$).

Example: R 21<cr><lf>

If the 710 does not recognize a command or an option number, it will send a bell character (ASCII 7) to the computer. When the bell character is received, the programmer can have a message sent to the screen indicating an error has occurred or have the command resent. An error is detected if the command (alpha character) or the option (numerals) is not recognized.

Mode Command

Mode commands determine if the other functions can be performed. (See Table C-3.) Note that there is no Mode command to turn ON or STOP the 710. Sending any character will turn the 710 ON. While in the Run Mode, a STOP can be performed by sending any character to the 710. The 710 will not respond with <cr><lf>.

COMMAND STRING	OPTION	RESPONSE
M1	Power Off	<cr><lf>
M2	Run	<cr><lf>
M3	Reset Data	<cr><lf>

Table C-3: Mode Commands

Query Command

The Query commands extract the current value of a particular parameter. (See Table C-4.)

COMMAND STRING	OPTION	RESPONSE FORMAT
Note: Each response format is followed by <cr><lf>.		
Q1	Criterion #1	0-200
Q2	Threshold #1	0-200
Q3	Exchange Rate #1	3-6
Q4	Criterion #2	0-200
Q5	Threshold #2	0-200
Q6	Exchange Rate #2	3-6
Q7	RMS Excd Level	0-200
Q8	Peak Excd Level	0-200
Q9	Excd Hysteresis	1-8
Q10	Time Hist Per	0-255

Table C-4: Query Commands

Read Command

The Read commands extract data from the 710. (See Table C-5.)

COMMAND STRING	OPTION	RESPONSE FORMAT
Note: Each response format is followed by <cr><lf>.		
R1	Current SPL	nnn.n
R2	Leq	nnn.n
R3	SEL	nnn.n
R4	Run Time	hhhhh:mm:ss.s
R5	TWA 1	nnn.n
R6	Dose 1	nnnn.n
R7	Projected Dose 1	nnnn.n
R8	TWA 2	nnn.n
R9	Dose 2	nnnn.n
R10	Projected Dose 2	nnnn.n
R11	Lmin	nnn.n
R12	Lmax	nnn.n
R13	LUwpk	nnn.n
R14	Overloads	nnn
R15	RMS Excd Count	nnn
R16	RMS Excd Time	nnnn.n
R17	Peak Excd Count	nnn
R18	Peak Excd Time	nnnn.n
R19	Stops	nnn
R20	Battery Level %	nnn
R21	Unit Name	30 char.
R22	Serial Number	cnnnn
R23	Firmware Revision	Vn.nnn ddmmmyyyy
R24	Calibration Offset Level	nnn.n
R25	Lock Mode/Combination	nnnn

Table C-5: Read Commands

Data and Set Commands

The Data and Set commands enter the parameter values. (See Table C-6 for a list of the Set commands.)

The value for each Set option is entered by a Data command immediately prior to entering the Set command. A Data command is limited to four characters: the "D" character and three numerals, including spaces but not including the carriage return.

Example: D 89<cr> S2<cr> sets Threshold #1 to 89 dB.

COMMAND STRING	OPTION	RESPONSE
S1	Criterion #1	<cr><lf>
S2	Threshold #1	<cr><lf>
S3	Exchange Rate #1	<cr><lf>
S4	Criterion #2	<cr><lf>
S5	Threshold #2	<cr><lf>
S6	Exchange Rate #2	<cr><lf>
S7	RMS Excd Level	<cr><lf>
S8	Peak Exced Level	<cr><lf>
S9	Exce Hysteresis	<cr><lf>
S10	Interval time 10sec ΔC S10 = 60sec	

Table C-6: Set Commands

Print Report Commands

The Print Report commands invoke the User 1 and User 2 reports. (See Table C-7.)

User 1 and User 2 refer to the names of customized keys on the keypad. User 1 prints a one page report. (See Appendix A.) User 2 is available with Model 710M and prints ten different history report formats. (See Appendix B.)

Before a computer can receive data from a Print Report command, the 710's Clear-to-Send line (pin 3) must be high. The computer can send a high signal with PRINT #1,CHR$(255). This enables one character to be sent from the 710 and must be done for each character in the report.

COMMAND STRING	OPTION	RESPONSE
P1	Print "User 1" Report	<cr><lf>
P2n	Print "User 2" Reports	<cr><lf>
P2	Peak Hist	< > < >
P3	RMS Hist	
n = 0-9		
P4	Time Hist	< > < >
P5	R3 and Q3	
H1	Ignore Handshaking	<cr>(if)

Table C-7: Print Commands

Sample Programming Statements

The following are written in the Basic language.

A typical OPEN statement:

OPEN "COM1:1200,N,8,2,CS,DS" AS #1

Commands can be sent to the 710 with PRINT statements, and data can be received with INPUT statements. The following will display the 25 Read values:

```
FOR A=1 TO 25
PRINT #1, "R"; A
INPUT #1, A$
PRINT A, A$
NEXT
```

Programming Precautions

To ensure proper programming of the 710, the following precautionary measures are recommended:

1. Before sending commands to the 710, check the communication link by sending a <cr>. When successfully connected, the 710 will respond with <ASCII 7><cr> (bell character). If the 710 is OFF, this will also power it ON.
2. Read data twice, and make sure both are the same.
3. After setting parameters, Query all of them, and make sure they are Set as desired.
4. Ensure that a command is not sent while the 710 is still sending data. The 710 is a half-duplex device; therefore, if it receives a character while it is sending data, the incoming character is ignored.
5. Data sent by the 710 terminates with a carriage return plus a linefeed. Commands must not be sent to the 710 until after a linefeed is received or until at least 10 ms after the carriage return is received.
6. Use the INPUT$ and LOC(x) functions in Basic to take in one character at a time. Discard all control codes less than a space character (ASCII 32_{10}) and terminate on the linefeed (ASCII 10_{10}). Response should be less than a second.

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