HWINPUT
PROGRAM USERS' GUIDE

**NOISE MEASUREMENT AND
ASSESSMENT FACILITY**

FEBRUARY 1992

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GLOSSARY OF TERMS

AWT (A-weight) - A series of weighting coefficients that are applied
to a measured sound level to alter the sensitivity of that level as a
function of frequency. The weighting coefficients are based upon the
sensitivity of the human ear.

Calibration (Single Level) - The process of adjusting measured noise levels based upon a known reference level.

Calibration Drift - A change in the measured calibration level associated with the electronic characteristics of a measuring system.

Calibration Level - A known reference level used to adjust measured levels. For the purposes of this document, the calibration level is 114 dB, re. 20 micropascal.

Cetec Ivie IE-30A Measuring System (IVIE) - A portable real time 1/3 octave spectrum analyzer/precision sound level meter. The FHWA measuring system is capable of simultaneously collecting noise data from up to eight of these units.

Configuration File (KONFIG FILE) - A user-created ASCII text file which contains setup information, including Ivie system numbers and reference level settings. The configuration files are a time-saving feature of HWINPUT and should be created prior to data collection in the field.

Data File - A file which contains measured noise level data in mean square pressure format, unadjusted for system calibration.

Identification Header - A user-inputted unique identification used to distinguish one data file from the next.

Interval - The user-selected averaging period. Data is sampled eight times per second and stored over the interval selected.

Multiple Level Calibration - A process used by personnel familiar with hardware operation to check system linearity. Note, when noise levels are processed with a multiple level calibration file using the companion program, HWNOISE, only the single level portion of the calibration file is used to correct the measured noise level data.

1/3 Octave Level - The processed noise level data for a particular 1/3 octave frequency band (14-43).

Reference Level - See Appendix B, Cetic Ivie IE-30A Interface Connections and Switch Settings.

SPL - The sound pressure level (SPL) calculated using processed noise level data. SPL is defined as 10 times the logarithm, base 10, of the mean square pressure, re. 20 micropascal.

System Linearity - See Appendix C, Theory of Operation, Figures 2 and 3, for system linearity specifications.

<u>HWINPUT</u>
<u>PROGRAM USERS' GUIDE</u>

1.0 <u>BACKGROUND</u>

HWINPUT is a VNTSC-developed user friendly program written in Microsoft Fortran version 4.01 for the IBM PC/AT. This program is an integral part of the Federal Highway Administration's Mobile Noise Data Gathering and Analysis Laboratory and is used to collect acoustic data from up to eight Cetec Ivie IE-30A measuring systems in intervals as short as 1/8 of a second. The 1/3 octave and A-weight sound pressure level (SPL) data is collected and stored on disk for later off-line processing using the companion program, HWNOISE.

Note: In the following, it is assumed that:

> **!** All operator entries are followed by striking 'ENTER'.
> **!** All operator entries are boldfaced and underlined.
> **!** All computer responses are in boldface caps.

2.0 SYSTEM SETUP

The following procedure must be performed to prepare the Federal Highway Administration's Mobile Noise Data Gathering and Analysis Laboratory for data collection:

! Provide A/C line power to the Laboratory via the external 1600 and 4800 watt sockets. Either direct hook-up to an A/C outlet or connection to the on-board Honda generators is sufficient.

! Turn on the IBM PC/AT computer and monitor, and the power supply mounted to the right-hand-side of the shelf beneath the computer.

! Connect preamps/microphones to the Ivie analyzers either directly or via cable, as appropriate.

! Connect the data I/O and battery charger cables to the eight Ivie analyzers. Insure all cables are connected to the eight analyzers, regardless of the number of systems to be used for data collection. Note, the plug on the end of the data I/O extension cable is very delicate. Insure the two releases are depressed when removing this plug from the 7 pin I/O connector on the Ivies.

! Turn on the eight Ivie analyzers and allow the entire system approximately 30 minutes to warm-up prior to use.

3.0 STARTUP

HWINPUT is resident on the "C" drive of the FHWA's IBM PC/AT computer. With the "C" drive prompt displayed on the monitor, type **HWINPUT** to invoke the program.

o   **C:>**   __**HWINPUT**__

The computer responds with the current version (date and time)
of the HWINPUT software. Insure the software is Version
04/01/91, 0800 Hours. The user is then prompted to select a
drive for data storage.

****

o   HWINPUT PROGRAM VERSION 04/01/91   0800 HOURS

****

DATE = 01/16/92 TIME = 12:47:13

DATA TO BE STORED ON DRIVE (A-Z)? __**C**__

Typing __**A**__, __**B**__, or __**C**__ selects the appropriate drive to store
collected noise data. Currently, the FHWA's IBM PC/AT computer
is capable of storing data on drive A, B, or C.

The computer responds with the input menu as follows:

```
o           HWINPUT MAIN MENU

    1 - SYSTEM CALIBRATION
    2 - COLLECT NOISE DATA
    3 - CHECK CALIBRATION DATA

    4 - CHANGE DISK DRIVE (DEFAULT = C)
    5 - DIRECTORY OF SELECTED DISK DRIVE
    9 - EXIT

    ENTER SELECTION:
```

Typing **1**, **2**, or **3** invokes the selection of interest explained in Sections 4.0, Data Collection, and 5.0, Check Calibration Data.

Typing **4** allows the user to change the disk drive used for data storage.

Typing **5** allows the user to view a directory of the selected disk drive and check storage capacity.

Typing **9** allows the user to exit the program.

4.0   DATA COLLECTION

NOTE: If a problem should occur during data collection, See Appendix A, Trouble Shooting Guide, for possible solutions.

4.1 SYSTEM CALIBRATION

With the main menu displayed, type **1** to collect calibration data.

o   **ENTER SELECTION:** ___1___

The program prompts the user for a single or multiple level calibration at 1kHZ (ANSI S1.11-1986 band 30). A multiple level calibration allows the user to obtain system linearity information and should only be used by operators experienced with system hardware.

A single level calibration example follows:

o   **SINGLE, DUAL, TRIPLE LEVEL (1, 2, 3)?** ___1___

The computer then allows the user to choose any one of three configuration files for use. If the file exists, it is read and displayed on the screen. If it does not exist, the user is prompted to create a new file, as appropriate.

o   **SINGLE LEVEL CALIBRATION**

KONFIG FILE NO.1 FOR MICS 1,2,3,4
KONFIG FILE NO.2 FOR MICS 5,6,7,8
KONFIG FILE NO.3 FOR 1 TO 8 MICS

WHICH FILE DO YOU WANT (1, 2, OR 3)? ___1___

In this example, the computer responds with the contents of configuration file number one (KONFIG FILE NO.1), as follows:

o   C:KONFIG   1991/ 3/ 2   3:19:22
           SINGLE LEVEL CALIBRATION (1kHZ, 10 SECONDS)

           IVIE#   DB REF LEV   CAL LEVEL
               1   110.0   114.0
               3   110.0   114.0
               4   110.0   114.0

This configuration example contains single level calibration
settings. The "IVIE#", i.e., measurement system number, is
displayed along with information on the expected Ivie's "DB REF
LEVEL" setting and the calibration level, "CAL LEVEL". Insure
the Ivie's "DB REF LEVEL" settings conform with the actual
settings of the respective analyzers.

The user has the option to use or change the selected
configuration file, or to view a new one.

o   CONFIGURATION SELECTION MENU

           0 - USE CONFIGURATION AS SHOWN
           1 - CHANGE THIS CONFIGURATION
           2 - VIEW A NEW KONFIG FILE

           ENTER SELECTION: _____1_____

Type **1** to change the configuration file.

The computer responds with the appropriate questions to create
a new calibration configuration file. In the following
example, the user chose to calibrate four systems, 1 through 4.
The reference level and calibration level are chosen to be 110
and 114 dB, respectively. In the case of a dual or triple
level calibration, additional prompts appear for "CAL LEV #2"
and "CAL LEV #3".

o   HOW MANY IVIES TO CALIBRATE (1-8)? _____4_____

           WHICH IVIES TO CALIBRATE?
           _____1_____

```
                    2
                    3
                    4
```

IVIE# 1 REF LEVEL? _____110_____

CAL LEVEL? _____114_____

IVIE# 2 REF LEVEL? _____110_____

CAL LEVEL? _____114_____

IVIE# 3 REF LEVEL? _____110_____

CAL LEVEL? _____114_____

IVIE# 4 REF LEVEL? _____110_____

CAL LEVEL? _____114_____

The computer responds with an updated configuration file. The user is given another opportunity to change it, if desired. Insure the Ivie's "DB REF LEVEL" settings conform with the actual settings of the respective analyzers.

o   **SINGLE LEVEL CALIBRATION (1kHZ, 10 SECONDS)**

IVIE#	DB REF LEVEL	CAL LEVEL
1	110.0	114.0
2	110.0	114.0
3	110.0	114.0
4	110.0	114.0

CONFIGURATION SELECTION MENU

0 - USE CONFIGURATION AS SHOWN
1 - CHANGE THIS CONFIGURATION
2 - VIEW A NEW KONFIG FILE

ENTER SELECTION: _____0_____

Upon typing **0**, the configuration file is used as shown.

The user is now prompted for a filename and a comment line (up to 80 characters) to be used as a unique identification header

for the calibration file.

o   **(NEW) CAL FILENAME: 1CAL0801**

           **ENTER COMMENTS FOR CAL FILE HEADER:
           INITIAL CALIBRATION, SYSTEMS 1 - 4**

A final two line prompt is given:

o   **STANDBY - READY TO INPUT CALIBRATION DATA**

           ****** HIT ENTER TO START ******

Insure all Ivie switch positions are set appropriately, and
calibrator(s) are properly set and placed on the appropriate
microphone/preamplifier(s) (See Appendix B, Cetec Ivie IE-30A
Interface Connections and Switch Settings). Hit 'ENTER' at the
appropriate time to start data collection.

The HWINPUT program keeps the user informed of data collection
by flashing:

o   𝄆𝄆 **COLLECTING DATA; PLEASE STANDBY** 𝄆𝄆

After collecting ten seconds of calibration data, the program
automatically stores the data on disk under the specified
filename. The HWINPUT program keeps the user informed of data
storage by flashing:

o   𝄆𝄆 **STORING DATA TO DISK; PLEASE STANDBY** 𝄆𝄆

The computer then displays the processed calibration data on

the screen. The user is urged to inspect this data carefully
before continuing. The "DIFF" values should be as close to
zero as possible. Further adjustment and recalibration of a
particular system may be necessary to minimize the "DIFF"
values for initial calibration. Allowable "DIFF" values for
initial calibration are ± 1.0 and ± 1.5 for the "SPL" and "1/3
OCT", respectively. **NOTE:** A calibration drift of several
tenths of a decibel is typical for a time period of four hours
between system calibrations. This drift can be minimized by
shortening the time between calibrations. A maximum time
period of 4 hours between calibrations is recommended.

o   **SINGLE LEVEL CALIBRATION (1 kHZ)**

IVIE#	CAL LEVEL	SPL	DIFF	1/3 OCT	DIFF
1	114.0	114.3	-0.3	114.0	0.0
2	114.0	113.9	0.1	114.1	-0.1
3	114.0	114.0	0.0	114.0	0.0
4	114.0	114.1	-0.1	114.2	-0.2

A printer prompt is issued.

o   **WANT TO PRINT THIS INFO (Y/N)?**

Type **Y** or **N**, as appropriate.

After calibration data is collected and stored, the main menu
is again displayed. Note, the above calibration procedure
should be repeated for measurement systems 5 through 8 (KONFIG
FILE NO. 2) if all eight systems are to be used during
measurements.

4.2 <u>COLLECT NOISE DATA</u>

With the main menu displayed, type **2** to collect noise data.

o   **ENTER SELECTION:** ____**2**____

The computer then allows you to choose any one of eight data
collection configuration files (KONFIG FILES).

o   **EIGHT KONFIG FILES AVAILABLE -**
               ENTER SELECTION (1-8): ____**1**____

If the configuration file exists, it is read and displayed on
the screen. If it does not exist, the user has the option of
creating a new file or choosing a different one.

o   **C: KONFIG 1991/ 3/ 2 8:45:22**

               IVIE#   DB REF LEVEL
                   1   80.0
                   2   80.0
                   3   80.0
                   4   80.0

The file selected contains system information from
configuration file number one, including the "IVIE#", i.e.,
measurement system number, and the "DB REF LEVEL" setting for
each analyzer. These settings must conform to the actual
settings of the respective analyzers. See Appendix B for the
appropriate settings.

The user has the option to either use the selected configuration file, to change the selected configuration file, or to view a new configuration file.

o   **CONFIGURATION SELECTION MENU**

        0 - USE CONFIGURATION AS SHOWN

        1 - CHANGE THIS CONFIGURATION

        2 - VIEW A NEW KONFIG FILE

        **ENTER SELECTION: 1   **

Type **1** to change the configuration file.

The computer responds with the appropriate questions to create a new configuration file. In the following example, the user selected eight Ivies, 1 through 8, and chose a "DB REF LEVEL" of 90 dB for all of them.

o   **HOW MANY IVIES (1-8)?   8   **

        **IVIE# 1 DB REF LEVEL?   90   **

        **IVIE# 2 DB REF LEVEL?   90   **

        **IVIE# 3 DB REF LEVEL?   90   **

        **IVIE# 4 DB REF LEVEL?   90   **

        **IVIE# 5 DB REF LEVEL?   90   **

        **IVIE# 6 DB REF LEVEL?   90   **

        **IVIE# 7 DB REF LEVEL?   90   **

        **IVIE# 8 DB REF LEVEL?   90   **

The computer responds with an updated configuration file.
Insure the Ivie's "DB REF LEVEL" settings conform with the
actual settings of the respective analyzers. The user has one
last opportunity to change the configuration file, if desired.

o   **C:KONFIG   1992/ 1/ 9   12:47:09**

              IVIE#   DB REF LEVEL
               1   90.0
               2   90.0
               3   90.0
               4   90.0
               5   90.0
               6   90.0
               7   90.0
               8   90.0

           WANT TO CHANGE THIS CONFIGURATION (Y/N)? ____N____

Upon typing **N**, the configuration file is used, as shown.

The user is prompted to select the averaging time and the
duration of the noise event. In the following example, 100
consecutive measurements are selected, each 1.0 second in
duration.

o   **SECS PER INTERVAL (IN INCREMENTS OF 0.125 SEC)? ___1.0___**

       NUMBER OF INTERVALS (120 MAX)? ___100___

The computer echoes back the selections and the user is given
one last opportunity to change them:

o   **NUMBER OF INTERVALS: 100 ; SECS PER INTERVAL: 1.000**

       WANT TO CHANGE THE AVERAGING TIME (Y/N)? ____N____

<u>Note:</u> The allowable number of intervals range between 1 and
     120, inclusive. The time for each interval ranges
 between 0.125 seconds and 36,000 seconds, inclusive.

The user is now prompted for a filename and a comment line (up
to 80 characters) to be used as a unique identification header
for the data file.

o   **(NEW) DATA FILENAME: <u> 1A0801 </u>**

           ENTER COMMENTS FOR DATA FILE HEADER:
           <u>TRUCK A - .25 SEC. AVG. - NORTH TO SOUTH RUN</u>

A final two line prompt is given:

o   **STANDBY - READY TO INPUT NOISE DATA**

           ******HIT ENTER TO START ******

Hit 'Enter' at the appropriate time to start data collection.
The HWINPUT program keeps the user informed of data collection
by flashing:

o   **((((COLLECTING DATA; PLEASE STANDBY ((((**

After collecting data for the user-selected time period, the
program automatically stores the data on disk under the user-
specified filename. The HWINPUT program keeps the user
informed of data storage by flashing:

o   **((((STORING DATA TO DISK; PLEASE STANDBY ((((**

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After data collection and storage is complete, the main menu is again displayed.

5.0   CHECK CALIBRATION DATA

With the main menu displayed, type **3** to check calibration data stored in any previously collected calibration file.

o   **ENTER SELECTION:** ____**3**____

The user is prompted for an old calibration filename. If the file does not exist, the program re-prompts.

o   **(OLD) CAL FILENAME:** __**1CAL0801**__

The computer responds with calibration level information, as follows:

o   **SINGLE LEVEL CALIBRATION (l kHZ)**

IVIE#	CAL LEVEL	SPL	DIFF	1/3 OCT	DIFF
1	114.0	114.3	-0.3	114.0	0.0
2	114.0	113.9	0.1	114.0	-0.1
3	114.0	114.0	0.0	114.0	0.0
4	114.0	114.1	-0.1	114.0	-0.2

In this example, the calibration data is from a single level calibration, as follows:

CAL LEVEL - The calibrator's absolute level (114 dB).
SPL   - The noise level measured from the Ivie's sound
            level meter output.
DIFF   - The difference between the calibrator's absolute
            level and the measured SPL.

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1/3 OCT    - The noise level measured in the 1kHz band of the
             Ivies' 1/3 octave band output.
DIFF       - The difference between the calibrator's absolute
             level and the measured 1/3 OCT.
```

A printer prompt is issued.

o   **WANT TO PRINT THIS INFO (Y/N)?**

Upon typing **Y** or **N**, as appropriate, the main menu is again
displayed.

Type **9** to exit the program.

6.0   <u>DATA ANALYSIS</u>

Data stored using HWINPUT can now be processed using the
companion program, HWNOISE.

APPENDIX A

Trouble Shooting Guide

1.0   INTRODUCTION

This Appendix contains instructions for correcting problems
that may be encountered during operation of the data collection
system.

2.0   TRIGGER/TIMING ERROR

SCENARIO	EXPLANATION	POSSIBLE SOLUTIONS
During data collection a red blinking message appears on the screen: "TRIGGER/TIMING ERROR IVIE NO.(X), INT NO.(Y) ** CHECK IVIES**"	Computer is not receiving the synchronization pulse(s) from the Ivie(s).	❗ TURN IVIE(S) ON. ❗ PLUG 7 PIN I/O CONNECTOR(S) INTO IVIE(S). (ITEM 11, APP.B) ❗ TURN ON POWER SUPPLY (BLACK BOX ON SHELF UNDER COMPUTER). ❗ REPLACE IVIE(S).

If the problem still exists restart the HWNOISE program and select
only the measurement system(s) which are operating properly. If
all else fails replace the interface card for the system that is
failing. Spare interface cards are stored in the drawers next to
the computer. Note, the interface box is located underneath the
computer to the left of the power supply.

3.0   IVIE ANALYZER FAILS

SCENARIO	EXPLANATION	POSSIBLE SOLUTIONS
At some period during measurements, an Ivie dies, i.e., Ivie display goes blank except for items 24, 20, and 8.	Battery is dead	❗ DISCONNECT AND RECONNECT THE A/C CHARGER PLUG. ❗ REPLACE IVIE(S).

When the Ivies are in a slow charge mode, i.e., green charge
indicator is on, they are not being charged fast enough to
maintain operation. If an Ivie remains in the slow charge mode
too long, the battery will die and its display will go blank.
When the charger plug is disconnected and reconnected, the
charging circuit is reset, i.e., red charge indicator is on, and
the unit will function properly. To insure a problem does not

occur, reset the charging circuit each time an Ivie's charge
indicator is green.

4.0   <u>DATA STORAGE DISK IS FULL</u>

<u>SCENARIO</u>	<u>EXPLANATION</u>	<u>POSSIBLE SOLUTIONS</u>
While storing measured data to disk the following message appears on the screen: "DISK OVERFLOW PAUSE REPLACE DISK WITH NEW DISK; HIT ENTER TO CONTINUE"	The present storage capacity has been exhausted.	**!** REPLACE CURRENT DISK WITH A NEW DISK AND HIT RETURN.

If this situation does occur, although the complete data file has
been successfully stored on the replacement disk, some editing may
be required before processing can begin.

5.0   <u>TIMING ERROR OCCURS</u>

<u>SCENARIO</u>	<u>EXPLANATION</u>	<u>POSSIBLE SOLUTIONS</u>
During data collection a red blinking message appears on the screen: "**** TIMING ERROR IVIE NO. (X) INT NO. (Y) ****"	Ivie(s) is not functioning properly.	**!** REPLACE IVIE(S).

This error occurs when the timing pulse(s) from the Ivie's analog
output varies from the manufacturers specifications.

APPENDIX B

**Cetec Ivie IE-30A Interface
Connections and Switch Settings**

1.0   <u>INTRODUCTION</u>

This Appendix contains the required interface connections (Table 1) and switch settings (Table 2) for the Cetec Ivie IE-30A analyzer. Refer to the figure on page B4 for corresponding Item Numbers.

TABLE 1:   IE-30A INTERFACE CONNECTIONS

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>INTERFACE CONNECTION</u>
2	Input Connector	The IE-3P Preamplifier should be plugged into each Ivie's input connector, either directly or by means of extension cable.
7	Pre-Amp Output	The RCA-Type plug connected to the signal ground of the IE-17PI extension cable should be plugged into the pre-amp output to insure a good ground.
9	Charger Input	To insure each Ivie is continually charged, the supplied charging unit should be connected to the charger input at all times.
11	7 Pin I/O Connector	The IE-17PI extension cable should be plugged into the 7 pin I/O connector on each Ivie. **<u>NOTE:</u>** The plug on the IE-17PI extension cable is very delicate. Insure the two releases are depressed when removing the plug from the 7 pin I/O connector on the Ivie.

TABLE 2: IE-30A SWITCH SETTINGS

ITEM NUMBER	DESCRIPTION	SWITCH POSITION	LED INDICATION
3	ON/OFF Power Switch	ON	
4	Digital Display of User Defined Reference Level	(*)	
5	Filter Format Switch for Screen Display	1/3	
6	10 dB step Adjustments for Item Number 4	SET AS REQUIRED	
8	Charge Indicators	(**)	
10	Memory Status Indicators	RT	
12	Memory Alternate Button (Switches Item 10 from RT to RCL)	--	
13	Memory Mode Switch	ST	
14	Memory Selector Switch	M1	
15	Decay Selector Switch	D1	
16	Freeze/Clear Button for SLM's Digital Display (Item 20)	CLR	
17	Response Display Selector Switch for SLM's Digital Display (Item 20)	CT	
18	Response Mode Selector Switch for SLM's Digital Display (Item 20)	FT	
19	Weighting Selector Switch for SLM's Digital Display (Item 20)	A	
20	Display of Measured SPL (For all cases number is AWT)	--	
23	Screen Display Resolution Switch	3	

(*)   The Reference level should be set to 110 dB during system calibration and adjusted for data collection, as required.

(**)   When the battery charger is plugged into the Ivie, the charge light indicator should alternate between a red indication (fast charge) and a green indication (slow charge). See Appendix A, Section, 3.0 for an explanation of the charger's operation.

APPENDIX C

Theory of Operation

1.0   INTRODUCTION

An IBM PC/AT is used to collect and store 1/3 octave and A-weight SPL data from up to eight Ivie IE-30A analyzers. The system uses a Data Translations 2821-16SE analog to digital plug-in board (A/D) and a real time clock board installed in the IBM PC/AT. The operation of both the A/D board and clock board are software controlled using both Microsoft Fortran and Assembly Language programs. Note, the last page of this Users' Guide contains a wiring diagram for the measurement system.

2.0   IVIE ANALYZERS

Analog data from up to eight GenRad 1962-9610 random incidence microphones attached to Ivie IE3P preamplifiers are fed through 500 Ft. cables connected to the input connectors of each Ivie IE-30A (Item 2, Appendix B). The Ivie IE-30A portable real time 1/3 octave spectrum analyzers/precision sound level meters process the analog information from up to eight microphone systems and feed 1/3 octave and A-weight SPL data through the A/D board to the IBM PC/AT for storage.

3.0   INTERFACE CONNECTIONS

Four of the seven outputs from the I/O connector (Item 11, Appendix B) of each Ivie are used as shown in Figure 1. A description of each signal follows.

PIN 1: GND   PIN 2: AWT SPL

                                                               PIN 5: SAW TIM

                                                               PIN 7: 1/3 OCT

FIGURE 1:   INTERFACE CONNECTIONS

3.1   ACOUSTIC SIGNALS

    The 1/3 octave (1/3 OCT) and A-weight SPL (AWT SPL) signals are
    fed directly to the 16 analog voltage input channels on the A/D
    board's terminal strip.   See Figure 4, block diagram of
    measurement system, for further clarification.

    3.1.1 1/3 OCTAVE

    With the display resolution switch (Item 23, Appendix B) set to
    3 dB/step, the 1/3 octave signal, pin 7, produces a linear output
    from 2.8 to 7.8 volts over a 50 dB dynamic range. The linearity
    limits for the 1/3 octave signal are shown in Figure 2.

    3.1.2 A-WEIGHT SPL

    The A-weight SPL signal, pin 2, has a 60 dB dynamic range, useable
    20 dB above the "dB reference line" and 40 dB below. The linearity
    limits for this signal are shown in Figure 3.

3.2   TIMING SIGNAL

    Each of the Ivie's sawtooth timing signals (SAW TIM), pin 5, are
    connected to an interface card housed in a blue box beneath the
    computer. The interface card converts the sawtooth signal into
    two TTL compatible signals, a trigger signal and a timing signal.
    The converted trigger and timing signals are then connected to the
    two 8 bit digital ports on the A/D board's terminal strip.

    The trigger signals mark the beginning and the end of each 1/3
    octave sweep signal coming from each Ivie (approximately 11.5
    msec.). Between two consecutive trigger pulses are 32 timing
    pulses representing the period for which the 1/3 octave level in
    each of the 32 1/3 octave bands are available for reading. The
    A/D board in conjunction with the IBM PC/AT sample the 32 1/3
    octave band levels using the trigger and timing pulses for each
    band level. After sampling the 32 bands for each Ivie, the A-
    weight SPL signal level, which requires no timing alignment, is
    sampled and stored.

4.0   DATA TRANSLATIONS A/D BOARD

The Data Translations 2821-16-SE A/D plug-in board converts the
analog voltages on analog channels 0 through 15 into a 12 bit
binary representation (i.e., 12 bit resolution). During operation
the data is continually transferred through the selected DMA
channels directly to the IBM PC/AT's memory at a 130 KHz
throughput, i.e., 130,000 samples per second.

5.0   UNITECH CLOCK CARD

The Unitech I/O Plus-III plug-in clock board is required in the
data collection system to ensure an accurate sampling time is
maintained. The 32 1/3 octave band levels and A-weight SPL signal
for all the Ivies selected are sampled and stored in computer
memory in a 125 msec. period ($\pm$ 1msec.).

6.0   SOFTWARE

After data collection is complete, the computer automatically
dumps the data to a file on a user-selected disk drive. Reduction
and processing can now be performed on the data file using the
companion program, HWNOISE.