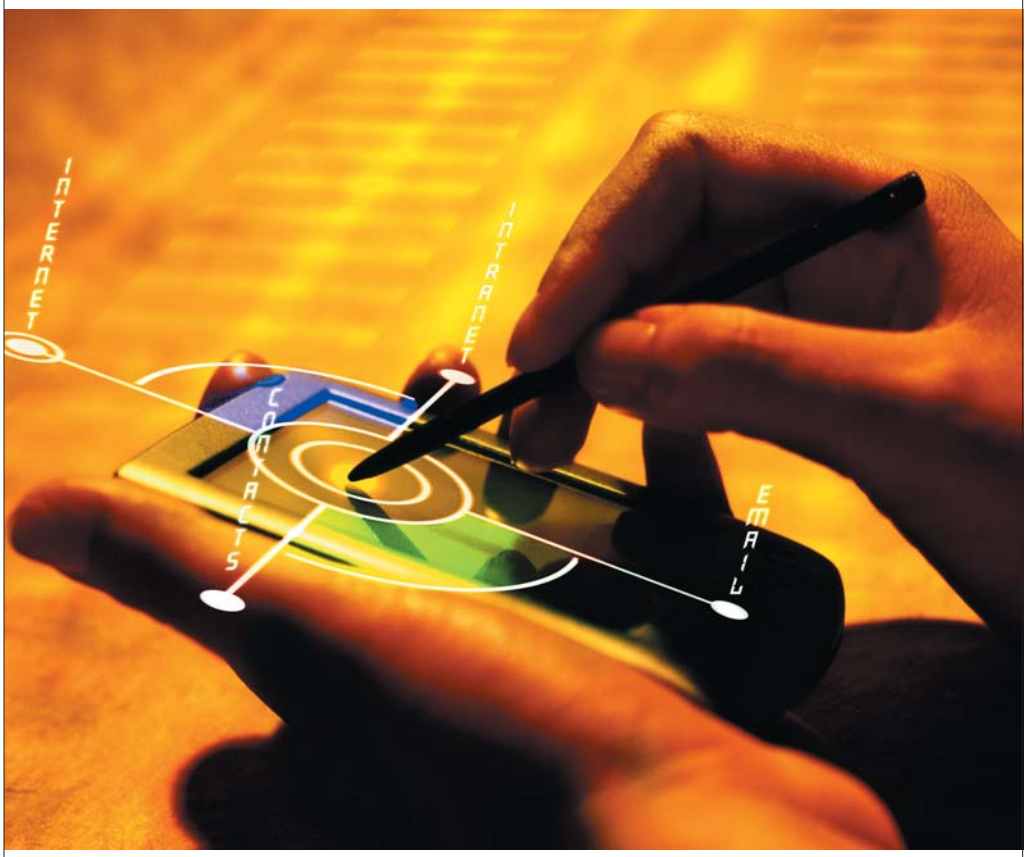

Ivie Technologies IE-33 Audio Analyzer

Audio test gear meets the pocket computer

Scott Wilkinson

Evaluating and optimizing a home theater audio system can be a daunting task. To do it properly, you need several pieces of expensive and bulky equipment, including a real-time analyzer (RTA), a sound-pressure level (SPL) meter, a signal generator, and one or more high-quality microphones with low-noise preamps. No wonder it helps to have a professional installer.

But even professional installers get tired of hauling around all that test gear. Fortunately, there is an attractive alternative: the IE-33 from Ivie Technologies, which turns an ordinary personal digital assistant (PDA) into a powerful audio analyzer (see **Fig.1**).

What You See Is What You Get

The IE-33 system consists of several parts. Of course, you need a PDA with sufficient power; a 400MHz processor is the minimum requirement. Also, it must conform to certain physical characteristics so it can fit in the IE-33's special plastic jacket, which houses the audio inputs: two line-level RCA inputs and a four-pin balanced and powered microphone input. The jacket also houses a low-noise preamp, a 20-bit A/D converter, and battery-management firmware.

Other elements of the Ivie system include a Type II omnidirectional condenser microphone, which is about 4 inches long and connects to the mike input on the jacket. A Type I mike, which exhibits greater precision (tighter tolerance) than a Type II, is available as an option for $1050. Still, the Ivie Type II mike is far more precise than most commonly available microphones, and it conforms to tighter tolerances than the ANSI spec for such mikes. Rounding out the hardware is a soft-sided carrying case that accommodates the PDA and microphone.

On the software side, the system comes with a CD-ROM with software for the PDA and a Windows PC, which is used to back up the data collected by the IE-33. Fortunately, you don't need a powerful PC to run the software; I had no trouble with it on my 500MHz laptop running Windows 98SE.

Among the compatible PDAs is the Compaq iPAQ 3900 series or above. The IE-33 system is available with or without the PDA; if you already have a compatible model, the jacket, mike, case, and software are available for $999. You can also buy a complete package, including a PDA and IE-33 system, from Ivie. The review package I got included an iPAQ 3950; by the time you read this, the base package will include an iPAQ 5555, which adds Bluetooth and WiFi capabilities but has the same processor speed as the 3950. The complete system price will be $1647. Of course, that price increases with more powerful and feature-laden PDAs, but they don't perform their IE-33 duties any better than the base model.

Set Up the Band

If you buy the complete package with PDA from Ivie, the software is preloaded and the hardware is preconfigured. However, if you already have a compatible PDA, you'll need to load the software and calibrate the system yourself. This is no big deal; loading software from a computer into a PDA is straightforward, and calibration consists of entering an offset number, which is included in the documentation, that corresponds to the individual microphone you have.

All PDAs come with a cradle that is used to charge the PDA's battery and connect it to a host PC. The cradle I got included serial and USB connectors; my laptop has both types of interfaces, but for some reason, only the serial connection worked. The iPAQ fit in the cradle with the jacket on, but would not seat easily onto the cradle's electrical connector.

Charging the battery took about 3.5 hours;

fully charged, it provided about 1.5 hours of use. An optional battery extender ($99) attaches to the back of the jacket. With 1840 milliamp-hours (mAh) of juice, the extender more than doubles the life of the iPAQ's internal battery.

Interestingly, many PDAs, including the iPAQ, slowly drain the battery even when the power is off—if you don't leave the PDA in its cradle, the software and data will be lost after a while. (During the review period, I unplugged it for five days, after which the IE-33 software and calibration were still intact.) To prevent losing the configuration settings, the IE-33 software stores the config file in a small section of nonvolatile memory, making it available if the software must be reinstalled.

During my execution of the initial setup procedure, the iPAQ didn't recognize the Ivie jacket, and it exhibited other problems, but these were due to the fact that I had an older version of the software; when I updated it to v.5.6.1, everything worked fine.

Fig.1: The Ivie Technologies IE-33 turns a compatible PDA into a powerful audio analyzer. The PDA is inserted into a special jacket that includes mike and line inputs, preamp, A/D converter, and battery-management firmware. Also included is a Type II microphone.

RTA Speedwagon

As with any PDA, you operate the IE-33 by tapping various "soft" buttons on the screen with the stylus. The four hardware buttons and 4-way cursor pad below the screen duplicate the action of certain soft buttons.

At the bottom of the screen are four pull-up menus. The File menu lets you set your preferences, select the input, and exit the program, while the Function menu lets you select the function you wish the IE-33 to perform. As you might expect, the Display menu provides options that affect the display of information, and the Info menu reveals the software version.

The IE-33 screen changes with the selected function, but in its default mode, the top half of the screen is an RTA display, showing the amplitude of different frequency bands in (almost) real time. (There is a slight processing lag, but this is to be expected in any RTA.) You can activate a peak-hold function that displays the highest level reached in each band during the measurement.

Another useful display option is called NC (for Noise Class), which is used to quantify ambient noise levels. (There's also an NR [Noise Rating] option, which is a similar quantification used mostly in Europe.) When you select NC in the Display menu, the RTA display switches to 1-octave resolution and is overlaid with curves representing different NC ratings (see **Fig.2**). The NC rating is determined by the band with the highest level and the NC curve it comes closest to. In my theater at midnight with the equipment powered on but not playing, the NC rating wavered between 29 and 30; a professional recording studio has a rating around 25.

The lower half of the screen presents the control buttons. At the left of the control area, four buttons let you select the resolution of the RTA display. This affects the display only; the actual data in every measurement are always taken at the maximum resolution: 2048 data points across the spectrum, all of which are processed once every 80 or 90 milliseconds.

The display-resolution settings include 1 Octave, ⅓ Octave, ⅙ Octave, and Max Res, which maps the 240 horizontal pixels on the iPAQ screen to separate frequency bands. Above 200Hz, each pixel represents, at most, 1/24 of an octave.

A couple of useful display options become available when Max Res is selected. One is LF Zoom, which uses the entire width of the display to draw the spectrum profile for only the low frequencies, up to 2kHz. The other option is Frequency Detect (see **Fig.3**), which identifies the frequency with the highest level at any moment. This is great for determining the frequency of any hums, buzzes, or other noises. By the time you read this, the IE-33 software will provide Frequency Detect at all display resolutions, not just Max Res.

At the far right of the control area is a window that displays various parameter values, depending on the selected function. In RTA mode, it displays the overall real-time level in user-selected units: dB SPL, dBV, dBu, and volts peak-to-peak and RMS. Also indicated is the selected weighting: A, C, or flat. Interestingly, the RTA display can be flat while the measurements are being taken with A or C weighting, which lets you see how the actual levels are affecting the weighted measurement. The SPL meter is a separate instrument with a broadband infinite impulse response (IIR) detector.

Below the resolution buttons is the Start/Stop button, which does as its name suggests. When you hit Stop, any frequency band can be selected, and its center frequency and level are displayed in the SPL window.

The middle column of onscreen buttons includes various controls. The Decay button changes the display's decay integration time, while the Weighting button lets you select A, C, or no weighting for the SPL measurements. The Speed button selects the response speed of the SPL meter: Fast, Slow, Impulse, or Peak.

Mem'ries

Across the top of the control area are 12 small buttons that let you store and access snapshots of the incoming data. Scratch (temporary) memories are numbered 1 through 9; if you tap one of the numbered buttons, it turns blue and the spectrum profile at that moment appears on the screen. If you tap other memory buttons, the corresponding profiles appear in different colors (see **Fig.4**). The

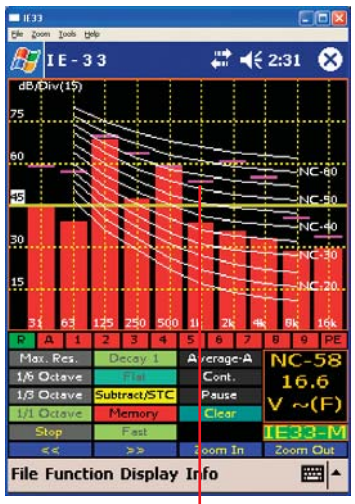

Fig.2: The NC option overlays standard NC curves on the 1-octave RTA display.

Fig.3: The Frequency Detect option identifies the frequency with the highest SPL.

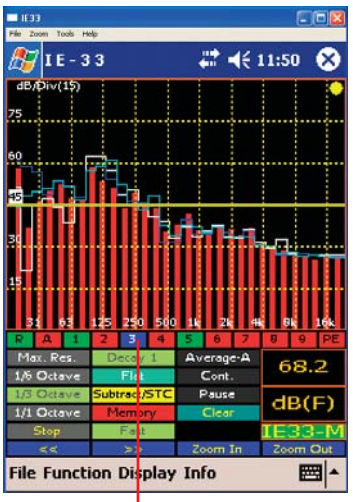

Fig.4: The spectral profiles in each memory location are displayed in different colors. The memory buttons with no data are red; those with data are green or blue (which indicates the last selected memory).

Memory button in the middle column of the control area calls up the memory screen, which lets you name, save, load, or clear any of the scratch memories, as well as other functions I'll get to shortly.

The Subtract/STC button brings up a screen that lets you select any two scratch memories and subtract one from the other. The resulting curve then appears in the main RTA screen. This is very powerful; for example, you could take nearfield and farfield measurements of pink noise from a speaker and subtract them to see the effect of the room. In my theater, those curves have similar shapes, offset by roughly 10dB in the midrange, 5dB in most of the high range, and 0dB in the bass and extreme high end (above 16kHz).

Also in the Subtract/STC screen is a button labeled STC/NIC, which calculates transmission loss through a barrier by comparing two selected memories. (STC stands for *sound transmission class*, NIC for *noise index class*, terms used by acousticians to quantify transmission loss.) This is useful in determining the sound isolation between two rooms. The IE-33 subtracts one memory from the other and performs various calculations to derive an STC number, which is displayed in the SPL window. In the RTA display, a green curve indicates the difference between the two spectra, and a white curve indicates the weighting used in the calculations (see **Fig.5**).

In my house, the home theater is next to the master bedroom. To determine the STC value of the wall between them, I played pink noise through one speaker at reference level (0dB on the receiver), measured the spectrum—with flat weighting—at a location in the theater near the common wall, and stored it in one memory location. Next, with the pink noise continuing to play, I performed the same measurement in the bedroom at the corresponding location near the common wall, storing that measurement in another memory. Then, I selected the two memories and had the IE-33 calculate the STC value. I got a value of 31, which is normal for standard wall construction. With double studs and double drywall construction, it should be possible to get an STC value of 50 to 60.

Technically, the STC calculation should be performed on two averaged spectra, one averaged from several locations along the common wall in the room with the noise source, the other averaged from readings at the corresponding locations in the adjacent room. The IE-33 makes this easy with its averaging function, which I'll discuss in a moment. I didn't get appreciably different results with this method in my theater compared with taking a single reading on each side of the wall.

In the Subtract/STC window, you can also select the real-time input signal from which to subtract a memory and get a continuous STC display. This lets you take a snapshot of the pink noise in the theater, then move the mike around the other side of the common wall to find the spots (doorjambs, etc.) where leakage is greatest, and at which frequencies.

The IE-33 lets you define and store one or more preferred spectral profiles. Tapping the PT button sets the display resolution to ⅓ octave and lets you select any band and set its level with the up/down cursor buttons. In this way, you can "draw" any curve you want, then equalize to the drawn curve. This is a great feature, but it's cumbersome to do. Of course, once it's done, you don't have to do it again. Still, I wish you could establish a profile by simply drawing on the screen with the stylus.

Average Pink Noise

The buttons in the column next to the SPL

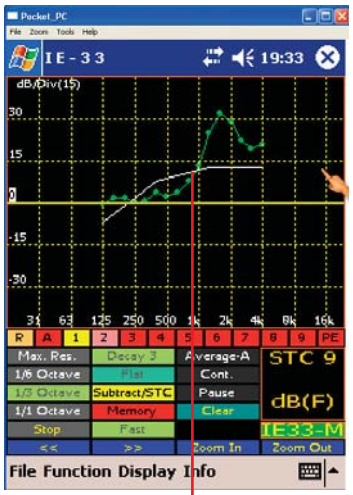

Fig.5: The STC/NIC function displays the difference between two spectra in green and the weighting used in the calculation in white.

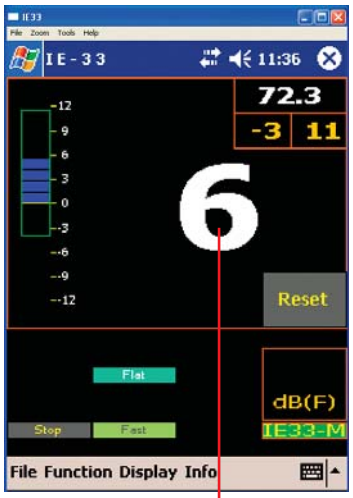

Fig.6: The Seat To Seat function reveals deviations in level from a "0" point defined by tapping the Reset button at one location in a room while pink noise is playing.

Fig.7: The Strip Chart displays the SPL as it changes over time.

window are associated with the process of averaging several spectra together. You can average measurements continuously, about four per second, or you can trigger individual measurements that are then averaged together. The curve representing the averaged spectrum is displayed on the RTA screen in blue, and it can be stored in any scratch memory.

Averaging facilitates some useful home theater applications. For example, you can play pink noise on the system, put the IE-33 in continuous averaging mode, and slowly walk around the room to get an average spectrum for the entire seating area. This normally requires several mikes in different locations, a microphone multiplexer (which outputs each mike's signal in rapid cyclic succession), and an RTA.

After taking an average spectrum of the seating area with the IE-33, you can pause the averaging (the RTA continues to function) and walk back through the seating area to find a spot where the real-time curve is as close as possible to the average curve. If you then place the EQ mike at that location, you'll be equalizing to the average response of the room.

Functions by the Junction

Along with a sophisticated RTA, the IE-33 offers several other useful functions. You can turn the entire display into an SPL meter with a big numerical readout and a bar-graph indicator that turns yellow and red at user-specified levels. The Weighting button also lets you isolate 1-octave bands centered at certain frequencies and measure the SPL in that octave only. For example, at 2kHz, you can see the level in the dialog-intelligibility range; at 4kHz, you can look at the high-frequency coverage at the edges of the room.

The Seat To Seat function presents a large numeric display and bar-graph indicator that ranges ±12dB from 0 (see **Fig.6**). Tapping the Reset button defines the "0" point as the SPL at that moment. Variations in the level are then indicated as above or below the 0 point. In addition to the bar graph, the maximum positive and negative values are indicated in two small windows in the upper right of the display, along with the real-time SPL. As with the SPL meter, you can apply different weightings and isolate 1-octave bands.

In a home theater, you can play pink noise, tap the Reset button, then walk around the listening area to see how even the coverage is from seat to seat. For example, you might look at 2 or 4kHz at different seats to see if you need to re-aim your tweeters. In my room, which is very small, there was virtually no difference between the two seats.

The Strip Chart simulates a pen-on-paper strip chart, plotting level over time. On the right side of the display is a triangle representing a "pen"; when you tap the Start button, the pen moves up and down, "drawing" a line on the strip of "paper," which "moves" horizontally (see **Fig.7**); the up-and-down motion indicates the SPL as it changes over time.

The time scale encompassed by the Strip Chart display can be set to any interval from one minute to eight hours, or to Continuous. Once the specified time period has elapsed, a Save As screen appears, letting you name and store the curve. In Continuous mode, you must stop it manually and tap the Save Chart button to do the same thing. The highest and lowest levels in a saved chart are marked; the level at any point can be read by placing the cursor at that point.

The Polarity function is way cool; it measures the polarity of the speakers in the system by sending a pulse signal from the headphone output of the iPAQ to an input on

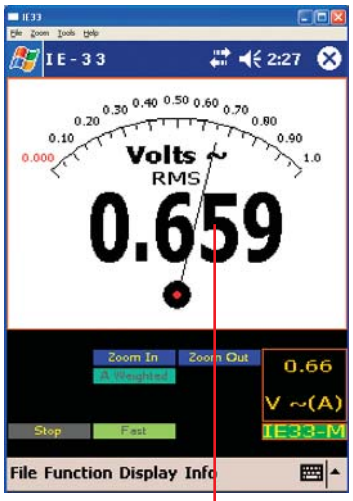

Fig.8: The Voltmeter measures the voltage at any of the IE-33's inputs.

the sound system. Put the mike in the nearfield vicinity of each speaker, and the display indicates the polarity with a big "+" or "–". Obviously, you want all speakers to be the same; mine were.

The Scope function turns the IE-33 into an oscilloscope. Onscreen buttons include Volts/Division (vertical resolution) and Time/Division (horizontal resolution). You can select the inputs to the Scope, including the microphone or Input 1 and/or Input 2. If you select Inputs 1 and 2, the Scope monitors both, and you can choose a dual-trace (both horizontal) or XY (one horizontal, the other vertical) display.

The Signal Generator function generates a sine, square, or triangle waveform as well as white or pink noise, and the signal comes out of the headphone jack or internal speaker. The frequency of the waveform is set with an onscreen slider and indicated in the SPL window. (If the frequency is set below 200Hz or so, you won't hear it from the PDA's tiny internal speaker.) You can start the Signal Generator and then switch to another function while it continues to play the selected signal, which is very handy.

The IE-33 can even function as a voltmeter that displays an "analog" needle meter as well as a numeric indicator (see **Fig.8**). The Voltmeter is designed only for audio levels, not AC power levels; anything up to +19dBu (about 7.5V RMS) is fine. To measure the voltage at any point in a circuit, all you need is a pair of leads with RCAs on one end and alligator clips on the other.

In the End

The Ivie Technologies IE-33 combines several instruments into one convenient unit that, when it's not analyzing audio signals, also acts as a normal PDA. It's much more efficient and cost-effective than having to lug around and set up several separate devices.

Even better, being a software-based product, new capabilities can be added to existing units. Ivie is working on three new software modules ($200–$250 each) that should be available by the end of the year. The first will calculate RT-60 (a measure of reverb time in a room), and the second will measure Lmax (the maximum SPL reached during each user-defined time period within a longer measurement) and all variations of Leq (the average SPL reached in each time period and how often it exceeded a given threshold). The third module will measure speech intelligibility by calculating the speech transmission index (STI) and other values related to this important factor in all home and commercial theaters.

I do have one wish in the hardware department: that the back of the IE-33's jacket had a threaded tripod mount, which would facilitate greater accuracy by avoiding handling noise. This wouldn't necessarily impede the battery extender, which could have a tripod mount as well to stand in for the one on the jacket that would be covered by the extra battery.

The IE-33 is a powerful tool for any custom installer or serious enthusiast. Once you start playing with it, you'll wonder how you ever got along without it.

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