THE COMMUNITY MEASUREMENT SYSTEM

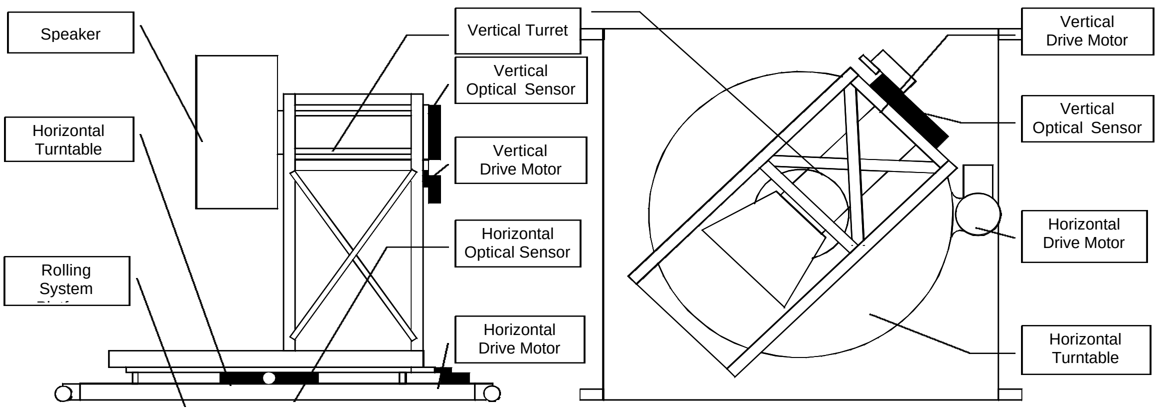

FIGURE 1: Pictogram of Rotator

Community's test system needs to be quite unique due to the variety of products to be tested. Its main function is accurate spherical positioning of the device under test (DUT). This includes products as diverse as small high frequency horns and systems weighing only a few pounds to large 250 lb. concert systems. The physical structure of the test system has to perform this function without presenting an acoustic obstruction. In addition, it also has to provide a means for easy mounting, dismounting, rotational positioning and measurement positioning of this wide variety of loudspeakers and systems.

Figure 1 shows the test apparatus. The vertical turret holds the speaker and rotates it axially. It is constructed of a open skeleton of square tubular steel designed to be as acoustically transparent as possible while being strong enough to support an array of large enclosures. This turret is mounted on skids to the horizontal rotation platform to allow for proper adjustment of the point of rotation for each system under test. Adjustable speaker mounting fixtures placed on the turret allow the speaker to be aligned axially.

Horizontal and axial rotation in five degree steps is accomplished via gear motors, optical position sensors and pneumatic brakes. This drive system is controlled via the TTL output of the TEF measurement system using Polar software. The Polar software collects a TDS amplitude response for each 5 degree rotation and stores it as an individual file. These files are grouped into sets of 36 files each, one set for each horizontal rotation and one file for each 5 degree step (plus one header file).

This results in 725 individual files requiring over 23 megabytes of storage space collected and stored for each quarter sphere directivity measurement. For products that do not have symmetrical vertical or horizontal dispersions a half sphere directivity measurement is used and the foregoing numbers essentially double.

The TEF Polar software post-processes the files into one octave and on third octave polar file sets of 18 files for quarter sphere and 37 files for one-half sphere measurements. These file sets are imported into a custom Excel spreadsheet with custom Visual Basic modules that further post-process and display the data in horizontal and vertical polar, isobar, beamwidth, and DI / Q charts. These charts are electronically cut and pasted directly onto the specification sheets. Every step of the post processing process has been carefully written to assure the integrity of the data. Our guiding philosophy has been to present detailed TEF data in a graphically pleasing and useful fashion without affecting the integrity of the data. To this end, all our Excel post-processing spreadsheets utilize the same algorithms for post-processing and displaying data as the TEF software. The end result is what you see in the published graphs. If you test the products yourself with a TEF measurement system under the same conditions you should get exactly the same result.

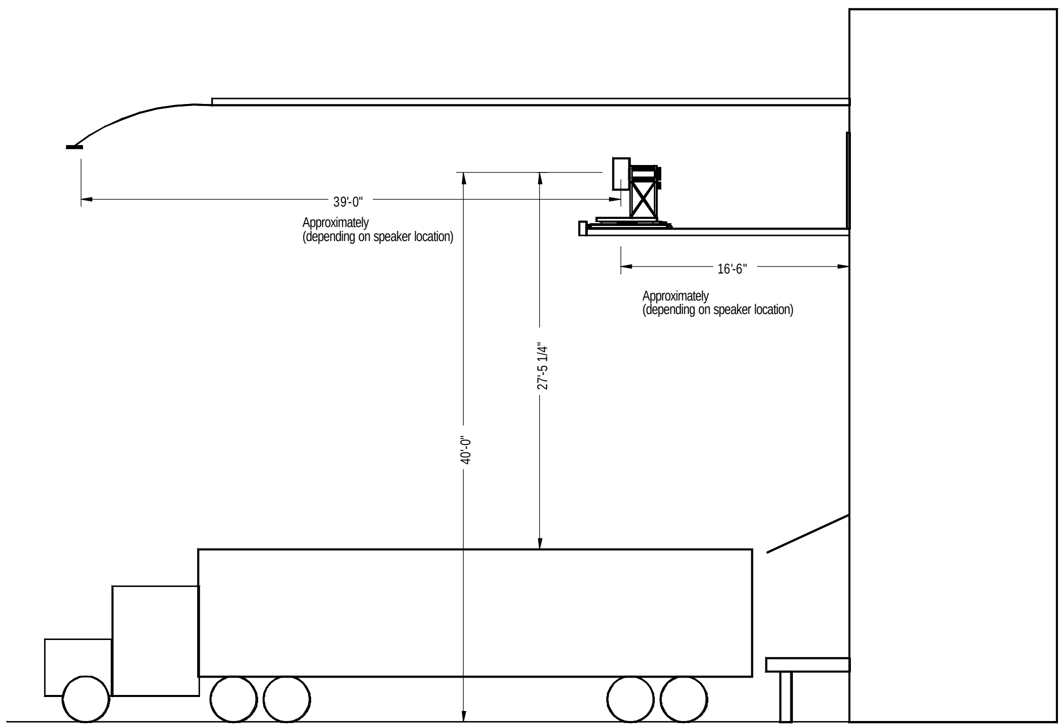

FIGURE 2: Pictogram of Test Environment

Our goal is to gather far field, free field measurements while achieving less than 10% error in three-dimensional directivity tests.

Figure 2 shows our test environment with microphone 39 ft. (~12 M) from the loudspeaker. Using Mark Ureda's isobar error probability equation we would have a maximum probability of error of 9.33% on our largest midrange horn and much less for the majority of our products, thus satisfying our far field and isobar accuracy goals.

To achieve a perfect free field measurement would require an environment completely free of reflective surfaces and completely free of any background noise. Since this is not practical, we placed the test system as far away from reflective surfaces as possible and choose test parameters for our TEF measurement system that would not allow these reflections to interfere with our measurements. We also utilized the noise immunity advantage of TDS measurements to reduce the interference of background noise.

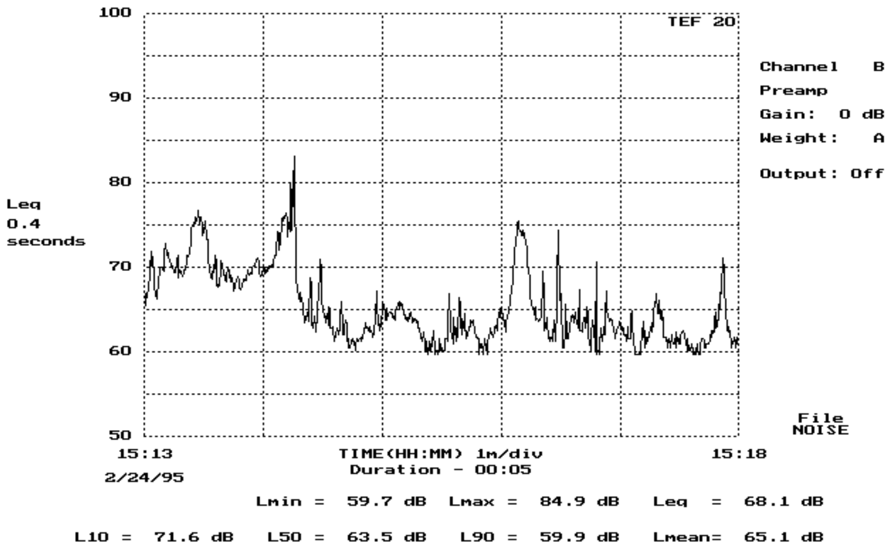

FIGURE 3a: Background noise level vs. time

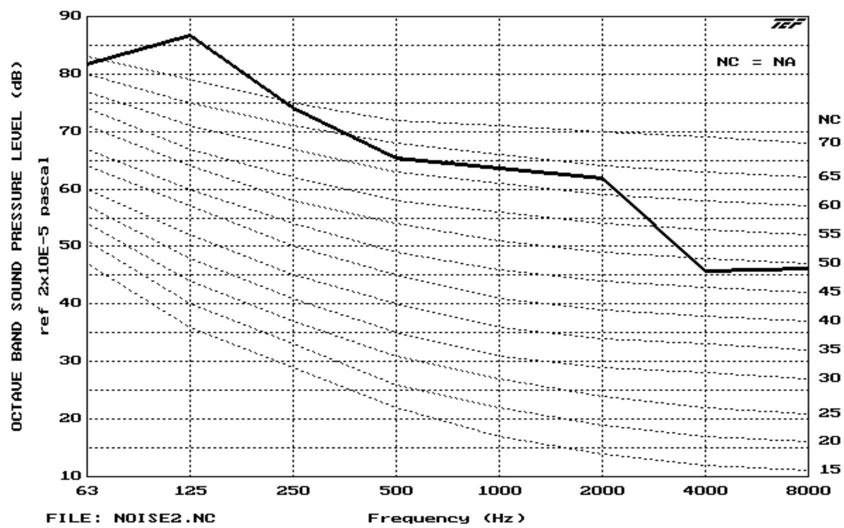

FIGURE 3b: Background noise level vs. frequency

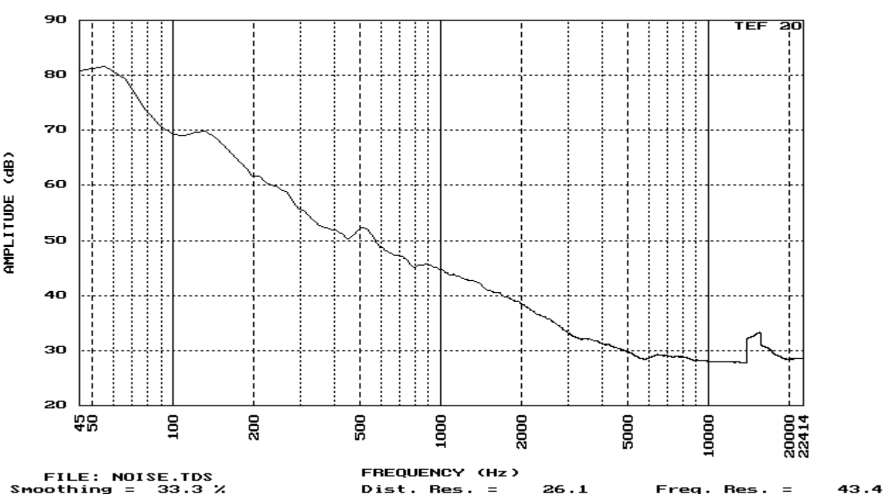

FIGURE 3c: Background noise level vs. frequency reduced by TDS measurement technique

The first step in reducing the effects of background noise was to measure its level related to time. For this test we used the TEF NLA software that measures SPL vs. time. This can be seen in Figure 3a. Since the testing was done outside above a parking lot and quite close to a minor highway several noise events were measured as expected. They included a truck idling below the microphone, truck accelerating out of the parking lot, cars passing on the highway and then finally a truck passing on the highway. As you can see the noise level varies from 60 to 85 dB SPL. Since the noise varies significantly with time, tests to determine frequency content would have to be averaged over time to get an accurate picture of frequency content.

Figure 3b shows how the noise level varies with frequency as measured by the TEF NC software. This measurement is the average of six measurements taken during six extreme events; truck driving by, truck in parking lot, employees departing, etc.

You can see that the noise level is significantly greater at low frequencies compared to high frequencies. To test in this environment with a system that did not attenuate noise would require a sound pressure level at the microphone of 125 dB at low frequencies and 85 dB at the highest frequencies, 40 dB above the noise floor for accurate polar measurements. Since this is not practical, the advantages of TDS measurement were called upon once again to help us achieve our free field measurement goal.

It is easy to measure the background noise as seen by a TEF TDS measurement by disconnecting the loudspeaker under test and performing a TDS test. The result is a measurement of background noise reduced by the TDS tracking filter. Figure 3c shows the resultant noise floor measured using this technique with the TEF measurement system set for 43 Hz frequency resolution which is approximately our standard resolution for virtually all but low frequency measurements.

As before, this measurement is the average of six measurements taken during six extreme events, truck driving by, truck in parking lot, employees departing etc. As you can see background noise is considerably lower than before. Also, background noise is more of a problem at lower frequencies and less of a problem at higher frequencies. This allowed us to measure high and mid frequency devices at a lower level than full range and subwoofer systems while maintaining an on axis SPL 40 dB above the noise floor.

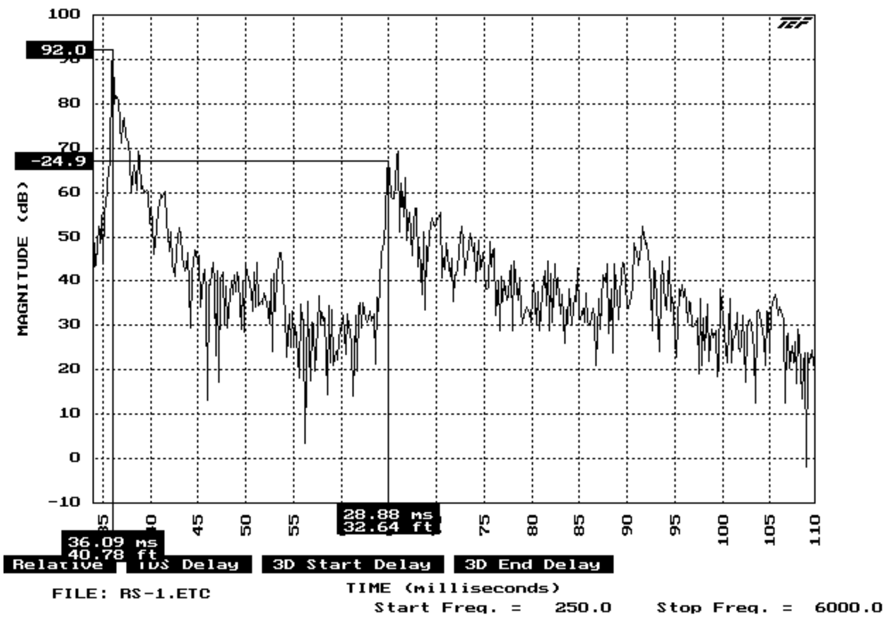

FIGURE 4: Energy Time Curve (ETC)

Figure 2 also shows the test environment with all acoustically significant boundaries. These boundaries include the building, parking lot, loading dock roof and any trucks that might be parked at the loading dock. These boundaries represent the limits of our TDS measurement window. They can be seen acoustically in the TEF Energy Time Curve (ETC) shown in Figure 4. This information guided us in selecting a maximum window of 26 feet allowing a 43 Hz. frequency resolution. There are varying opinions, but most people would agree that with this resolution, our measurements are accurate 86 Hz and above.

For low frequency data taken at 10 Hz resolution the window is over 100 feet. However, by using a microphone distance of 10 feet or less and high input levels, the direct sound is far in excess of any reflected sound or intrusive noise thus eliminating their effects on the data literally by "brute" force.

Through use of TDS measurement techniques utilized in the TEF measurement system, an environment free of reflective surfaces close to the loudspeaker under test, and long measurement distances, we are able to collect polar, SPL and harmonic data in an accurate and practical manner.

ELECTRONIC MEASUREMENT SYSTEM

To ensure accurate and consistent measurements, Community's electronic measurement system is carefully calibrated and maintained. Additionally, variables inherent in the testing system that would result in inaccurate data have been eliminated. Figure 2 shows the electronic signal flow for typical measurements.

The B&K 4007 measurement microphone and TEF20 system is calibrated for every set of measurements using a B&K 4230 piston-phone. Comparisons are also made at regular intervals to a B&K 2209 SPL meter with a B&K 4165 capsule as a further check. Resistors, measured to 1/100 of an ohm using a 4-wire, 6-1/2 digit HP3468A ohmmeter, are used to maintain calibration for the impedance measurements.

Test signal amplitudes are measured using three meters, a Fluke 87 series 3 and HP3468A true RMS meters, as well as a Ballantine 310A analog meter. This ensures continuing verification of all test signal voltages. Both the Fluke and HP meter calibrations are traceable to the National Bureau of Standards.

The impedance of the speaker cable and its voltage loss has been measured and is taken into account for all measurements during data post-processing. The measuring distances are determined using the TEF20. For SPL measurements such as sensitivity, the distance from the microphone to the face of the loudspeaker is used. The SPL loss between the face of the loudspeaker and the actual acoustic origin is figured in during data post processing. Without this step, resulting SPL figures would be artificially high.

Software modules for the TEF20 system are used for all measurements: directivity data, impedance, SPL, RTA, TDS, and others as needed.

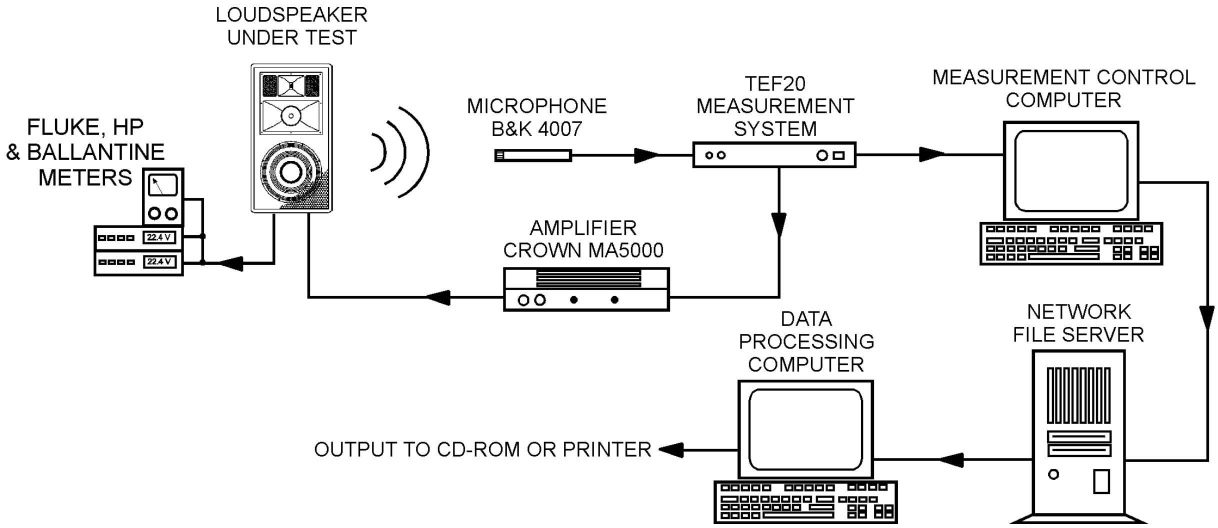

FIGURE 5: Pictogram of Electronic Measurement Set-up

The measurement methodologies employed and post-processing programs have a number of crosschecks, redundancies, and verifications built-in to ensure that correct and accurate data has been being collected. This avoids reliance on single, isolated measurements that may be in error. Most importantly, data is examined and comparisons are continually hand made between different products or different measurements on the same product to see that the measured data makes sense.

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Community Professional Loudspeakers