Measuring Speaker Sensitivity Using Audio Precision Gear

1. Understanding Speaker Sensitivity

Speaker sensitivity is a measure of how efficiently a speaker converts electrical power into acoustic sound. It is typically expressed as the sound pressure level (SPL) in decibels (dB) produced by a speaker at a distance of 1 meter when driven with 1 watt of power.

2. Equipment and Setup

a. Audio Precision Analyzer

- **Types**: Models like the APx555 or APx525 are commonly used in audio testing. They offer precision signal generation and analysis, making them ideal for measuring speaker sensitivity.
- **Connections**: The AP analyzer should be connected to the power amplifier, which drives the speaker. The microphone, placed at 1 meter from the speaker, is connected to the analyzer to capture the acoustic output.

b. Microphone

- **Calibration**: Use a calibrated measurement microphone (e.g., B&K 4133 or similar) designed for accurate SPL measurement. It must be calibrated with a sound level calibrator (typically at 94 dB SPL at 1 kHz) before the test.
- **Positioning**: The microphone should be placed exactly 1 meter away from the speaker, aligned with the axis of the speaker's primary output (e.g., center of the woofer or horn).

c. Power Amplifier

- **Power Requirements**: The amplifier should be capable of delivering a stable 1-watt output to the speaker. This corresponds to 2.83V RMS for an 8-ohm speaker or 2V RMS for a 4-ohm speaker.
- **Connection**: The amplifier is connected to the output of the AP analyzer, which supplies the test signal.

d. Acoustic Environment

- **Anechoic Chamber**: Ideally, measurements should be taken in an anechoic chamber to eliminate reflections that could affect the SPL reading.
- **Quiet Room**: If an anechoic chamber is not available, a large, quiet room with damping materials can be used, though this may introduce some error due to reflections.

3. Signal Generation and Measurement

a. Setting Up the Test Signal

- **Signal Type**: A pure sine wave at 1 kHz is the standard for sensitivity measurements. However, for full characterization, a swept sine wave or pink noise may also be used.
- **Voltage Setting**: The signal generator within the AP analyzer should be configured to output 2.83V RMS (for an 8-ohm load) or 2V RMS (for a 4-ohm load) to ensure the speaker is receiving exactly 1 watt of power.

    - **Calculation**:
        - **Power (P) = Voltage (V)^2 / Impedance (Z)**
        - For an 8-ohm speaker: P=2.832/8P = 2.83^2 / 8P=2.832/8 = 1 watt
        - For a 4-ohm speaker: P=22/4P = 2^2 / 4P=22/4 = 1 watt

b. Measurement Process

- **Initial Calibration**: Run the signal through the amplifier and check the voltage at the speaker terminals using a multimeter to ensure it matches the desired value (2.83V or 2V).
- **Capture SPL**: With the signal playing, the microphone picks up the acoustic output, and the AP analyzer records the SPL at 1 meter. The measurement should be displayed in dB SPL.

4. Advanced Measurements

a. Frequency Response Measurement

- **Swept Sine Wave**: To understand how sensitivity varies with frequency, use a swept sine wave from 20 Hz to 20 kHz. The AP analyzer will record the SPL at each frequency point, generating a sensitivity curve.
- **Pink Noise**: Pink noise can also be used to simulate real-world audio content, providing a broad-spectrum SPL measurement.

b. Impedance Considerations

- **Different Impedances**: If the speaker has a nominal impedance other than 8 ohms, adjust the voltage to maintain 1 watt of power. This ensures consistent sensitivity measurements across different speaker types.
- **Impedance Curve**: The AP analyzer can also measure the impedance curve of the speaker, which is useful for understanding how the load varies with frequency.

c. Environmental Factors

- **Temperature and Humidity**: These can affect both the speaker and the microphone. It's best to measure under controlled conditions and document environmental variables.
- **Background Noise**: Ensure background noise is minimized. Even in a quiet room, ambient noise should be at least 10 dB lower than the speaker output to avoid contamination of the measurement.

5. Data Analysis and Interpretation

a. Interpreting SPL Data

- **Sensitivity Rating**: The SPL value recorded at 1 meter with 1 watt input is the sensitivity rating of the speaker. For example, if the SPL is 90 dB, the speaker is said to have a sensitivity of 90 dB @ 1W/1m.
- **Comparison**: Use this value to compare the efficiency of different speakers. Higher sensitivity means the speaker produces more sound with less power.

b. Analyzing Frequency Response

- **Flatness**: Ideally, a speaker should have a flat sensitivity curve across the audible spectrum. Variations can indicate how well the speaker reproduces different frequencies.
- **Peaks and Dips**: Identify any peaks or dips in the sensitivity curve that may indicate resonance issues or poor performance at certain frequencies.

c. Reporting Results

- **Documentation**: Create a detailed report that includes the SPL values, sensitivity curve, test conditions (environment, microphone type, etc.), and any anomalies observed.
- **Comparison with Specifications**: Compare your results with the manufacturer's specifications to ensure the speaker is performing as expected.

Conclusion

Measuring speaker sensitivity using Audio Precision gear is a precise process that involves careful setup and calibration. By following the steps outlined above, you can obtain accurate and reliable sensitivity measurements that are critical for evaluating speaker performance.