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Micro-electromechanical systems (MEMS) technology - Test methods for the performance of MEMS capacitive microphones

微机电系统（MEMS）技术 MEMS电容式麦克风性能试验方法

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Foreword

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01 State Administration for Market Regulation The State Administration for Standardization issued a statement.

1.Scope This document describes the test conditions and methods for the performance of MEMS condenser microphones at the wafer and device levels. This document applies to MEMS condenser microphones used in the air with a frequency range of 20Hz to 20kHz.

4 Test conditions

4.1 General Requirements The default measurement conditions specified in this document are free field. If additional conditions are required, they should be explicitly specified. To obtain the correct measurement conditions, the procedure should be performed according to the requirements provided by the device manufacturer.

4.2 Atmospheric conditions Temperature. 15°C~35°C; Relative humidity. 20%~80%; Atmospheric pressure. 86 kPa~106 kPa.

4.3 Other environmental conditions In addition to the atmospheric conditions mentioned above, the test should also be conducted under the following environmental conditions.

a) Magnetic field. The test site should be free of any external magnetic fields that may affect the test results, except for the Earth's magnetic field;

b) Mechanical vibration. The test site should be free from mechanical vibrations that could affect the test results.

4.4 Testing System Figure 1 shows the MEMS condenser microphone (hereinafter referred to as "microphone") performance testing system. Figure

1 Test System Diagram The center of the sound source and the microphone should be on the same horizontal line, with a distance of 0.5m or 1m between them. The audio analyzer should preferably be placed in an anechoic chamber or semi-anechoic chamber. Outside the sound chamber. Before testing, the test system should be calibrated using a standard microphone. The testing system includes the following.

a) Sound source. For noise-related tests, the noise level of the sound source should be at least 10 dB lower than the equivalent input noise of the microphone under test. For total harmonic... For the total harmonic distortion test, the total harmonic distortion of the sound source should be less than 1/10 of that of the microphone under test.

b) Standard microphone. The frequency response curve is flat within the 20Hz~20kHz frequency range, with a deviation within ±0.5dB; sensitivity... Long-term stability. <=0.02dB/year; acoustic overload point >=140dB; background noise <=20dB.

c) DC power supply. Voltage fluctuations should be controlled within ±0.1%, and the ripple factor should be less than 0.1%.

d) Audio analyzer. Amplitude accuracy should be higher than ±0.01dB, frequency accuracy should be higher than 0.005%, and harmonic distortion should not be higher than -110dB. The effective measurement frequency range should cover the 5th harmonic frequency or higher.

Note. An audio analyzer can also be replaced by a system consisting of a signal generator and a spectrum analyzer.

e) Voltmeter. The voltage resolution should be better than 1% of the difference between the microphone's no-load output voltage and its output voltage under load. Range selection. It is 1 to 2 times the voltage to be measured.

f) Oscilloscope. Used to observe and analyze the microphone's output waveform and determine the microphone's polarity.

6 Microphone Performance Test Methods

6.1 Output Impedance The output impedance is tested using the following two methods.

a) Acoustic signal method. A sound pressure signal of a certain magnitude is applied to the microphone through a sound source, and the output voltage of the microphone under no-load conditions is measured using a voltmeter. Output voltage (U2); Connect the load resistor (R1) to the microphone output terminal and measure the output voltage (U1) after loading. Formula (1) is used to calculate the output impedance (Z).

6.2 Sensitivity A sinusoidal sound pressure signal with a sound pressure level of 94 dB (i.e.,

1 Pa) and a frequency of 1 kHz was input to the microphone. Under this excitation, the microphone's signal strength was tested. The output number is used to calculate the sensitivity using formulas (3) to (6).

6.3 Background noise Tests should be conducted in an anechoic or semi-anechoic chamber, where the ambient background noise should be at least 6 dB lower than the microphone's equivalent input noise, and as low as possible. Low, to reduce the interference of environmental noise on the test results. In the absence of an external sound field, the microphone output signal was measured, and the weighting method in 7.2.1A of GB/T 12060.1-2017 was used to calculate... The microphone's noise floor value Nf is obtained.

6.4 Signal-to-noise ratio Calculate the signal-to-noise ratio (SNR) according to formula (7) (expressed in logarithmic form).

6.5 Acoustic Overload Point With the microphone in no-load condition, apply the rated operating voltage and sinusoidal sound pressure signals of different sound pressure levels and a frequency of 1kHz, and measure... The microphone's total harmonic distortion (THD). When the microphone's THD reaches 10%, the input sound pressure level is at the acoustic overload point (maximum acoustic distortion). enter).

6.6 Dynamic Range The dynamic range is the difference between the acoustic overload point and the reference signal input (94dB sound pressure level), plus the signal-to-noise ratio, based on... Formula (8) is used for calculation and expressed in logarithmic form.

6.7 Frequency Response By applying sound pressure signals of different frequencies with a constant amplitude to a sound source, and sweeping the frequency from the lower limit to the upper limit, the microphone's on/off state is measured. The open-circuit output voltage was obtained, and the ratio of the open-circuit output voltage to the 1kHz open-circuit output voltage (expressed in logarithmic form) was plotted as a function of frequency.

6.8 Polarity The test should be conducted in an anechoic chamber or semi-anechoic chamber environment, where the ambient noise should be at least 10 dB lower than the sound pressure signal output by the sound source. The microphone is placed in the sound field, and the oscilloscope simultaneously reads the input waveform of the audio analyzer and the output waveform of the microphone. The signal is then analyzed to determine the signal strength. The trend of signal change. when the instantaneous sound pressure increases, the instantaneous output signal of the microphone also increases, then the polarity is positive; when the instantaneous sound pressure increases, but the microphone... If the instantaneous output signal decreases, then the polarity becomes negative.

6.9 Equivalent Input Noise The equivalent input noise is calculated using formula (9) or formula (10).

6.10 Total Harmonic Distortion A sinusoidal sound pressure signal with a specified sound pressure level and a frequency of 1 kHz is applied to the microphone, and the voltage (Unf) of each harmonic component is measured. Total voltage at the fundamental frequency (Ut).

6.11 Power Supply Rejection Ratio Tests should be conducted in an anechoic or semi-anechoic chamber, where the ambient background noise should be at least 6 dB lower than the microphone's equivalent input noise. In the absence of an external sound field, a signal with the desired frequency and magnitude Vin is superimposed on the specified power supply voltage, and the microphone output (U) is read. Formula (13) is used to calculate the power supply rejection ratio (PSRR).