

CAPACITANCE MEASURING CIRCUIT CAPACITANCE MEASURING INSTRUMENT AND MICROPHONE DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a circuit and a device that detect electrostatic capacitance, especially relates to the circuit, the device and a microphone device that detect very small capacitance with high accuracy.

BACKGROUND ART

[0002] As a prior art of an electrostatic capacitance detection circuit, that described in Japanese Laid-Open Patent Application H09-280806 gazette can be cited. FIG. 1 is a circuit diagram that shows this electrostatic capacitance detection circuit. In this detection circuit, a capacitive sensor 92 comprised of electrodes 90 and 91 is connected to an inverting input terminal of an operational amplifier 95 via a signal line 93. And a capacitor 96 is connected between an output terminal of this operational amplifier 95 and the said inverting input terminal, and further an AC voltage Vac is applied to a non-inverting input terminal. Also, the said signal line 93 is wrapped up by a shield line 94 and shielded electrically against disturbance noise. And this shield line 94 is connected to the non-inverting input terminal of the operational amplifier 95. Output voltage Vd is obtained from an output terminal of the said operational amplifier 95 via a transformer 97.

[0003] In this detection circuit, the inverting input terminal and the non-inverting input terminal of the operational amplifier 95 are in an imaginary short status, so that the signal line 93 connected to the inverting input terminal and the shield line 94 connected to the non-inverting input terminal have the almost same potential. Thereby, the signal line 93 is guarded by the shield line 94, that is, stray capacitance between the signal line 93 and the shield line 94 is canceled, and the output voltage Vd, which is unlikely to be affected by the stray capacitance, can be obtained.

[0004] According to this kind of conventional art, when capacitance of the capacitive sensor 92 is big to some extent, it is indeed possible to obtain accurate output voltage Vd, which is not affected by the stray capacitance between the signal line 93 and the shield line 94. However, when very small capacitance, which equals to or is less than an order of several pF or fF (femtofarad), is detected, an error is increased.

[0005] Also, depending on a frequency of the AC voltage Vac applied, a subtle displacement of a phase and amplitude consequently arises between the voltage of the inverting input terminal and that of the non-inverting input terminal, which are in the imaginary short status, due to a tracking error in the operational amplifier 59, and thereby the detection error becomes bigger.

[0006] On the other hand, for lightweight and small audio communication devices represented by a mobile phone or the like, there has been a demand of a compact amplifier circuit that sensitively and faithfully transforms sounds detected by a capacitive sensor such as a capacitor microphone into an electric signal. If it is possible to accurately detect very small capacitance that equals to or is less than several pF or fF and/or its change, a high performance

microphone that can detect sounds with a very high level of sensitivity and fidelity is realized, and thereby performance for picking up sounds by the audio communication devices such as a mobile phone will make rapid progress.

[0007] This invention is devised in view of the above-mentioned situation, and aims at providing an electrostatic capacitance detection circuit and the like that are capable of accurately detecting very small capacitance, and suitable to detect capacitance of a capacitive sensor such as a capacitor microphone used for lightweight and compact audio communication devices.

DISCLOSURE OF THE INVENTION

[0008] In order to achieve above objectives, the electrostatic capacitance detection circuit according to the present invention is an electrostatic capacitance detection circuit that outputs a detection signal corresponding to electrostatic capacitance of a capacitor to be detected, comprising: an impedance converter of which input impedance is high and output impedance is low; a first capacitive impedance element; an operational amplifier; an AC voltage generator that applies AC voltage to the operational amplifier; and a signal output terminal that is connected to an output of the operational amplifier, wherein an input terminal of the impedance converter is connected to one end of the capacitor and one end of the first impedance element, the first impedance element and the impedance converter are included in a negative feedback loop of the operational amplifier, and the capacitor and the electrostatic capacitance detection circuit are located adjacently.

[0009] Also, the electrostatic capacitance detection circuit according to the present invention is an electrostatic capacitance detection circuit that outputs a detection signal corresponding to electrostatic capacitance of a capacitor to be detected, comprising: an impedance converter of which input impedance is high and output impedance is low; a first capacitive impedance element; an operational amplifier; an AC voltage generator that applies AC voltage to the operational amplifier; and a signal output terminal that is connected to an output of the operational amplifier, wherein an input terminal of the impedance converter is connected to one end of the capacitor and one end of the first impedance element, the first impedance element and the impedance converter are included in a negative feedback loop of the operational amplifier, and the capacitor, the first impedance element and the impedance converter are located closely.

[0010] As a specific example, the electrostatic capacitance detection circuit is structured to comprise an AC voltage generator, an operational amplifier of which non-inverting input terminal is connected to specific potential, an impedance converter, a resistance connected between an inverting input terminal of the operational amplifier and an output terminal of the impedance converter, a capacitor (a first impedance element) connected between an output terminal of the operational amplifier and an input terminal of the impedance converter. A capacitor to be detected is connected between the input terminal of the impedance converter and the specific potential, and the electrostatic capacitance detection circuit and the capacitor to be detected are located adjacently or are set closely at a short distance that does not make the stray capacitance of the signal line exceed ten times as much as maximum capacitance of an element