the input of the buffer. The at least one diode is electrically coupled between the output of the amplifier and the second end of the second resistive element.

[0011] In some embodiments, the buffer is a second amplifier that has an inverting input, a non-inverting input, and an output. The output of the second amplifier is electrically coupled to the inverting input of the second amplifier. In this configuration, the non-inverting input of the second amplifier is the input of the buffer and the output of the second amplifier is the output of the buffer.

[0012] In some embodiments, the electrometer also includes a computational unit electrically coupled to the outputs of the amplifier and the buffer. The computational unit computes a current level based on the resistance values of the first and second resistive elements and the voltage levels at the outputs of the amplifier and the buffer.

[0013] In some embodiments, the resistance of the first resistive element is greater than the resistance of the second resistive element. The resistance of the second resistive element can be between 10 megaohms and 100 megaohms and the resistance of the second resistive element can be between 5 gigaohms and 50 gigaohms. In some embodiments, the ratio between the resistance values of the resistive elements is greater than 10.

[0014] In some embodiments, the plurality of diodes include a first diode and a low-leakage and low-capacitance second diode, each of which have a first end and a second end. The first end of the second diode is electrically coupled to the input of the buffer and the second end of the second diode is electrically coupled to the first diode. In some embodiments, the first diode is a small signal silicon diode. In some embodiments, the electrometer also includes a third resistive element electrically coupling the second end of the second diode to ground.

[0015] In some embodiments, the electrometer also includes a capacitor and an adjustable gain amplifier that has an input and an output. The input of the adjustable gain amplifier can be electrically coupled to the second end of the second diode. The output of the adjustable gain amplifier can be electrically coupled to the first end of the second diode through the capacitor. The adjustable gain amplifier is configured to discharge the capacitor with a charge opposite the charge in the second diode.

[0016] In some embodiments, the electrometer also includes a temperature controller that is coupled to at least the second diode, the amplifier, and the high-impedance buffer. In some embodiments, the plurality of diodes includes pairs of diodes, where the diodes in each pair

the input of the buffer. The at least one diode is electrically coupled between the output of the amplifier and the second end of the second resistive element.

[0011] In some embodiments, the buffer is a second amplifier that has an inverting input, a non-inverting input, and an output. The output of the second amplifier is electrically coupled to the inverting input of the second amplifier. In this configuration, the non-inverting input of the second amplifier is the input of the buffer and the output of the second amplifier is the output of the buffer.

[0012] In some embodiments, the electrometer also includes a computational unit electrically coupled to the outputs of the amplifier and the buffer. The computational unit computes a current level based on the resistance values of the first and second resistive elements and the voltage levels at the outputs of the amplifier and the buffer.

[0013] In some embodiments, the resistance of the first resistive element is greater than the resistance of the second resistive element. The resistance of the second resistive element can be between 10 megaohms and 100 megaohms and the resistance of the first resistive element can be between 5 gigaohms and 50 gigaohms. In some embodiments, the ratio between the resistance values of the resistive elements is greater than 10.

[0014] In some embodiments, the plurality of diodes include a first diode and a low-leakage and low-capacitance second diode, each of which have a first end and a second end. The first end of the second diode is electrically coupled to the input of the buffer and the second end of the second diode is electrically coupled to the first diode. In some embodiments, the first diode is a small signal silicon diode. In some embodiments, the electrometer also includes a third resistive element electrically coupling the second end of the second diode to ground.

[0015] In some embodiments, the electrometer also includes a capacitor and an adjustable gain amplifier that has an input and an output. The input of the adjustable gain amplifier can be electrically coupled to the second end of the second diode. The output of the adjustable gain amplifier can be electrically coupled to the first end of the second diode through the capacitor. The adjustable gain amplifier is configured to discharge the capacitor with a charge opposite the charge in the second diode.

[0016] In some embodiments, the electrometer also includes a temperature controller that is coupled to at least the second diode, the amplifier, and the high-impedance buffer. In some embodiments, the plurality of diodes includes pairs of diodes, where the diodes in each pair

The invention claimed is:

1. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer; and

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element,

wherein the buffer is a second amplifier having an inverting input, a non-inverting input, and an output, the output of the second amplifier being electrically coupled to the inverting input of the second amplifier, the non-inverting input of the second amplifier being the input of the buffer and the output of the second amplifier being the output of the buffer.

2. The electrometer of claim 1 further comprising a computational unit electrically coupled to the outputs of the amplifier and the buffer, the computational unit being configured to compute a current level based on the resistance values of the first and second resistive elements and the voltage levels at the outputs of the amplifier and the buffer.

3. The electrometer of claim 1 wherein the resistance of the second resistive element is greater than the resistance of the first resistive element.

4. The electrometer of claim 3 wherein the first resistive element is between 10 megaohms and 100 megaohms and the second resistive element is between 5 gigaohms and 50 gigaohms.

5. The electrometer of claim 3 wherein the ratio between the resistances of the resistive elements is greater than 10.

6. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer;

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element, wherein the at least one diode comprises a first diode and a low-leakage and low-capacitance second diode having a first end and a second end, the first end of the second diode electrically coupled to the input of the buffer, the second end of the second diode electrically coupled to the first diode;

a capacitor; and

an adjustable gain amplifier having an input and an output, the input of the adjustable gain amplifier electrically coupled to the second end of the second diode, the output of the adjustable gain amplifier electrically coupled to the first end of the second diode through the capacitor, the adjustable gain amplifier being configured to discharge the capacitor with a charge opposite the charge in the second diode.

7. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the

amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer;

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element;

a first anti-alias filter and a second anti-alias filter, the first anti-alias filter electrically coupled to the output of the amplifier, the second anti-alias filter electrically coupled to the output of the buffer; and

a first analog-to-digital (A/D) converter and a second A/D converter, the first A/D converter electrically coupled to the output of the first anti-alias filter, the second A/D converter electrically coupled to the output of the second anti-alias filter, the first A/D converter and the second A/D converter.

8. A method for measuring current, comprising:

sensing a first voltage at an output of an amplifier;

computing a current based on the first voltage and a resistance of a first resistive element electrically coupled between an inverting input of the amplifier and the output of the amplifier if the first voltage is below a predetermined level;

sensing a second voltage at the output of a buffer;

computing a current based on the first and second voltages and the resistances of the first resistive element and a second resistive element, the second resistive element being electrically coupled between the inverting input of the amplifier and an input of the buffer, if the voltage output from the amplifier is above the predetermined level;

sampling a change in forward voltage of at least one of a plurality of diodes electrically coupled between the input of the buffer and the output of the amplifier; and

injecting a first charge into the at least one of the plurality of diodes, the first charge being opposite to a second charge associated with the at least one of the plurality of diodes.

9. The method of claim 8 further comprising adjusting the level of the first charge to match the second charge associated with the at least one of the plurality of diodes.

10. A method for measuring current, comprising:

sensing a first voltage at an output of an amplifier;

computing a current based on the first voltage and a resistance of a first resistive element electrically coupled between an inverting input of the amplifier and the output of the amplifier if the first voltage is below a predetermined level;

sensing a second voltage at the output of a buffer; and

computing a current based on the first and second voltages and the resistances of the first resistive element and a second resistive element, the second resistive element being electrically coupled between the inverting input of the amplifier and an input of the buffer, if the voltage output from the amplifier is above the predetermined level,

wherein sensing the voltages comprises reading first voltage data output from a first A/D converter electrically coupled to the output of the amplifier and reading second voltage data output from a second A/D converter electrically coupled to the output of the buffer.

11. The method of claim 10 further comprising:

applying a zero-input signal to the inverting input of the amplifier; and

reading first voltage data from the first A/D converter to obtain zero-input voltage data, wherein computing a current based on the resistance of the first resistive element comprises computing a difference between the first voltage data and the zero-input voltage data and dividing the result by the resistance of the first resistive element to obtain first current data.

12. The method of claim 11 further comprising:

reading second voltage data from the second A/D converter to obtain second zero-input voltage data, wherein computing a current based on the resistances of the first resistive element and the second resistive element comprises computing a difference between the second voltage data and the second zero-input voltage data and dividing the result by the resistance of the second resistive element to obtain second current data, and summing the first current data and the second current data.

The invention claimed is:

1. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer; and

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element,

wherein the buffer is a second amplifier having an inverting input, a non-inverting input, and an output, the output of the second amplifier being electrically coupled to the inverting input of the second amplifier, the non-inverting input of the second amplifier being the input of the buffer and the output of the second amplifier being the output of the buffer.

2. The electrometer of claim 1 further comprising a computational unit electrically coupled to the outputs of the amplifier and the buffer, the computational unit being configured to compute a current level based on the resistance values of the first and second resistive elements and the voltage levels at the outputs of the amplifier and the buffer.

3. The electrometer of claim 1 wherein the resistance of the second resistive element is less than the resistance of the first resistive element.

4. The electrometer of claim 3 wherein the second resistive element is between 10 megaohms and 100 megaohms and the first resistive element is between 5 gigaohms and 50 gigaohms.

5. The electrometer of claim 3 wherein the ratio between the resistances of the resistive elements is greater than 10.

6. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer;

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element, wherein the at least one diode comprises a first diode and a low-leakage and low-capacitance second diode having a first end and a second end, the first end of the second diode electrically coupled to the input of the buffer, the second end of the second diode electrically coupled to the first diode;

a capacitor; and

an adjustable gain amplifier having an input and an output, the input of the adjustable gain amplifier electrically coupled to the second end of the second diode, the output of the adjustable gain amplifier electrically coupled to the first end of the second diode through the capacitor, the adjustable gain amplifier being configured to discharge the capacitor with a charge opposite the charge in the second diode.

7. An electrometer, comprising:

an amplifier having an inverting input, a non-inverting input, and an output;

first and second resistive elements each having a first end and a second end, the first ends of the first and second resistive elements electrically coupled to the inverting input of the

amplifier and the second end of the first resistive element electrically coupled to the output of the amplifier;

a buffer having a high-impedance input and an output, the second end of the second resistive element electrically coupled to the input of the buffer;

at least one diode electrically coupling the output of the amplifier to the second end of the second resistive element;

a first anti-alias filter and a second anti-alias filter, the first anti-alias filter electrically coupled to the output of the amplifier, the second anti-alias filter electrically coupled to the output of the buffer; and

a first analog-to-digital (A/D) converter and a second A/D converter, the first A/D converter electrically coupled to the output of the first anti-alias filter, the second A/D converter electrically coupled to the output of the second anti-alias filter, the first A/D converter and the second A/D converter.

8. A method for measuring current, comprising:

sensing a first voltage at an output of an amplifier;

computing a current based on the first voltage and a resistance of a first resistive element electrically coupled between an inverting input of the amplifier and the output of the amplifier if the first voltage is below a predetermined level;

sensing a second voltage at the output of a buffer;

computing a current based on the first and second voltages and the resistances of the first resistive element and a second resistive element, the second resistive element being electrically coupled between the inverting input of the amplifier and an input of the buffer, if the voltage output from the amplifier is above the predetermined level;

sampling a change in forward voltage of at least one of a plurality of diodes electrically coupled between the input of the buffer and the output of the amplifier; and

injecting a first charge into the at least one of the plurality of diodes, the first charge being opposite to a second charge associated with the at least one of the plurality of diodes.

9. The method of claim 8 further comprising adjusting the level of the first charge to match the second charge associated with the at least one of the plurality of diodes.

10. A method for measuring current, comprising:

sensing a first voltage at an output of an amplifier;

computing a current based on the first voltage and a resistance of a first resistive element electrically coupled between an inverting input of the amplifier and the output of the amplifier if the first voltage is below a predetermined level;

sensing a second voltage at the output of a buffer; and

computing a current based on the first and second voltages and the resistances of the first resistive element and a second resistive element, the second resistive element being electrically coupled between the inverting input of the amplifier and an input of the buffer, if the voltage output from the amplifier is above the predetermined level,

wherein sensing the voltages comprises reading first voltage data output from a first A/D converter electrically coupled to the output of the amplifier and reading second voltage data output from a second A/D converter electrically coupled to the output of the buffer.

11. The method of claim 10 further comprising:

applying a zero-input signal to the inverting input of the amplifier; and

reading first voltage data from the first A/D converter to obtain zero-input voltage data, wherein computing a current based on the resistance of the first resistive element comprises computing a difference between the first voltage data and the zero-input voltage data and dividing the result by the resistance of the first resistive element to obtain first current data.

12. The method of claim 11 further comprising:

reading second voltage data from the second A/D converter to obtain second zero-input voltage data, wherein computing a current based on the resistances of the first resistive element and the second resistive element comprises computing a difference between the second voltage data and the second zero-input voltage data and dividing the result by the resistance of the second resistive element to obtain second current data, and summing the first current data and the second current data.