SUMMARY

[0006] In a first aspect of the present invention, a motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device is disclosed. The motor driver circuit comprises a non-inverting buffer circuit, an inverting buffer circuit, and a scalar circuit. The scalar circuit comprises a Supply Tracked Common Mode Voltage (VCMSC) generation circuit, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, and wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

[0007] In a second aspect of the present invention, a MEMS device is disclosed. The MEMS device comprises a MEMS micro-mirror, a motor coupled to a MEMS micro-mirror, and a motor driver circuit. The motor driver circuit comprises a non-inverting buffer circuit, an inverting buffer circuit, and a scalar circuit. The scalar circuit comprises a VCMSC generation circuit, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, and wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

[0008] In a third aspect of the present invention, a method of controlling a MEMS micro-mirror is disclosed. The method comprises coupling a non-inverting buffer circuit, an inverting buffer circuit, and a scalar circuit to a motor driving a MEMS micro-mirror, the scalar circuit comprising a VCMSC generation circuit, and configuring the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit, together with the VCMSC generation circuit, to provide a common voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

SUMMARY

[0006] In a first aspect of the present invention, there is provided a motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device, the motor driver circuit comprising: a non-inverting buffer circuit; an inverting buffer circuit; and a scalar circuit, the scalar circuit comprising a Supply Tracked Common Mode Voltage (VCMSC) generation circuit, wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, the VCMSC generation circuit automatically tracking the common mode voltage independent of at least one of variations in supply voltage to the scalar circuit and variations to the scalar gain of the scalar circuit to provide the common mode voltage having linear direct current (DC) current-voltage characteristics to the motor for driving the motor.

[0007] In a second aspect of the present invention, there is provided a motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device, the motor driver circuit comprising: a non-inverting buffer circuit; an inverting buffer circuit; and a scalar circuit, the scalar circuit comprising a Supply Tracked Common Mode Voltage (VCMSC) generation circuit, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a

control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is coupled to the control supply voltage, the second resistor bridge is coupled to the driver supply voltage, and the variable resistor bridge is configured with the first and second resistor bridges to change the VCMSC voltage in response to a change in at least one of the control supply voltage and the driver supply voltage.

[0008] In a third aspect of the present invention, there is provided a MEMS device, comprising: a MEMS micro-mirror; a motor coupled to a MEMS micro-mirror; and a motor driver circuit, the motor driver circuit comprising: a non-inverting buffer circuit; an inverting buffer circuit; and a scalar circuit, the scalar circuit comprising a VCMSC generation circuit, wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to the motor in response to a VCMSC voltage generated by the VCMSC generation circuit, the VCMSC generation circuit automatically tracking the common mode voltage independent of at least one of variations in supply voltage to the scalar circuit and variations to the scalar gain of the scalar circuit to provide the common mode voltage having linear direct current (DC) current-voltage characteristics to the motor for driving the motor.

[0008a] In a fourth aspect of the present invention, there is provided a MEMS device, comprising: a MEMS micro-mirror; a motor coupled to a MEMS micro-mirror; and a motor driver circuit, the motor driver circuit comprising: a non-inverting buffer circuit; an inverting buffer circuit; and a scalar circuit, the scalar circuit comprising a VCMSC generation circuit, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is coupled to the control supply voltage, the second resistor bridge is coupled to the driver supply voltage, and the variable resistor bridge is configured with the first and second resistor bridges to change the VCMSC voltage in response to a change in at least one of the control supply voltage and the driver supply voltage.

CLAIMS

What is claimed is:

1. A motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a Supply Tracked Common Mode Voltage (VCMSC) generation circuit,

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, and

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

2. The motor driver circuit in accordance with claim 1, wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is configured to modify the control supply voltage, the second resistor bridge is configured to modify the driver supply voltage, and the variable resistor bridge is configured to modify any one or a combination of the control supply voltage or the driver supply voltage to generate the VCMSC voltage.

3. The motor driver circuit in accordance with claim 2, wherein the variable resistor bridge comprises binary weighted parallel resistors.

4. The motor driver circuit in accordance with claim 1, wherein the motor is positioned in a rest position in response to the common mode voltage.

5. The motor driver circuit in accordance with claim 1, wherein the scalar circuit further comprises binary weighted parallel resistors configured to modify scalar gain of the scalar circuit.

6. The motor driver circuit in accordance with claim 4, wherein the binary weighted parallel resistors are configured to be controlled by a digital code.

7. The motor driver circuit in accordance with claim 1, wherein the VCMSC generation circuit is configured to track the common mode voltage automatically.

8. The motor driver circuit in accordance with claim 5, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide the common mode voltage to the motor in response to a VCMSC voltage generated by the VCMSC generation circuit automatically, independent of variations in supply voltage to the scalar circuit and/or variations to the scalar gain of the scalar circuit.

9. A MEMS device, comprising:

a MEMS micro-mirror;

a motor coupled to a MEMS micro-mirror; and

a motor driver circuit, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a VCMSC generation circuit,

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, and

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

10. The MEMS device in accordance with claim 9, wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is configured to modify the control supply voltage, the second resistor bridge is configured to modify the driver supply voltage, and the variable resistor bridge is configured to modify any one or a combination of the control supply voltage or the driver supply voltage to generate the VCMSC voltage.

11. The MEMS device in accordance with claim 10, wherein the variable resistor bridge comprises binary weighted parallel resistors.

12. The MEMS device in accordance with claim 9, wherein the motor is positioned in a rest position in response to the common mode voltage.

13. The MEMS device in accordance with claim 9, wherein the scalar circuit further comprises binary weighted parallel resistors configured to modify scalar gain of the scalar circuit.

14. The MEMS device in accordance with claim 12, wherein the binary weighted parallel resistors are configured to be controlled by a digital code.

15. The MEMS device in accordance with claim 9, wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit automatically, independent of variations in supply voltage to the scalar circuit and/or variations to the scalar gain of the scalar circuit.

16. A method of controlling a MEMS micro-mirror, the method comprising:

coupling a non-inverting buffer circuit, an inverting buffer circuit, and a scalar circuit to a motor driving a MEMS micro-mirror, the scalar circuit comprising a VCMSC generation circuit; and

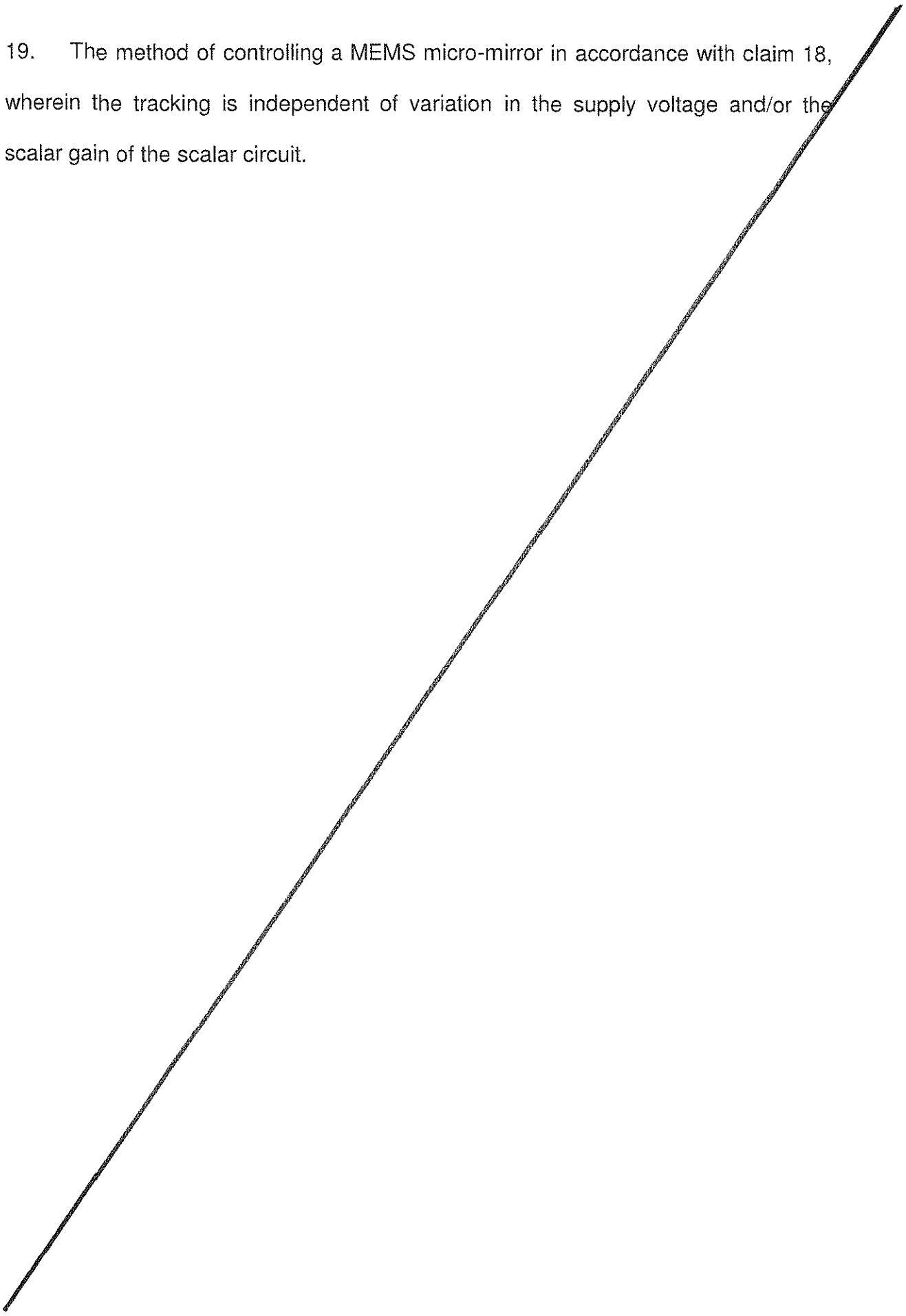
configuring the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit, together with the VCMSC generation circuit, to provide a common voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit,

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit.

17. The method of controlling a MEMS micro-mirror in accordance with claim 16, the method further comprising, after the configuring step, positioning the motor in a rest position in response to the common mode voltage generated by the VCMSC generation circuit.

18. The method of controlling a MEMS micro-mirror in accordance with claim 16, wherein the step of configuring further comprises tracking the common mode voltage via the VCMSC generation circuit automatically.

19. The method of controlling a MEMS micro-mirror in accordance with claim 18, wherein the tracking is independent of variation in the supply voltage and/or the scalar gain of the scalar circuit.



CLAIMS

What is claimed is:

1. A motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a Supply Tracked Common Mode Voltage (VCMSC) generation circuit,

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit, the VCMSC generation circuit automatically tracking the common mode voltage independent of at least one of variations in supply voltage to the scalar circuit and variations to the scalar gain of the scalar circuit to provide the common mode voltage having linear direct current (DC) current-voltage characteristics to the motor for driving the motor.

2. A motor driver circuit for a Micro-electro-mechanical systems (MEMS) micro-mirror device, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a Supply Tracked Common Mode Voltage (VCMSC) generation circuit,

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit,

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and

wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is coupled to the control supply voltage, the second resistor bridge is coupled to the driver supply voltage, and the variable resistor bridge is configured with the first and second resistor bridges to change the VCMSC voltage in response to a change in at least one of the control supply voltage and the driver supply voltage.

3. The motor driver circuit in accordance with claim 2, wherein the variable resistor bridge comprises binary weighted parallel resistors.

4. The motor driver circuit in accordance with claim 1, wherein the linear DC current-voltage characteristics comprise a programmable DC current-voltage slope, and wherein the VCMSC generation circuit is further configured to provide the common mode voltage

having the programmable slope to the motor, the motor being in a rest position in response to the control supply voltage being at its common mode.

5. The motor driver circuit in accordance with claim 3, wherein the binary weighted parallel resistors are configured to be controlled by a digital code.

6. A MEMS device, comprising:

a MEMS micro-mirror;

a motor coupled to a MEMS micro-mirror; and

a motor driver circuit, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a VCMSC generation circuit,

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to the motor in response to a VCMSC voltage generated by the VCMSC generation circuit, the VCMSC generation circuit automatically tracking the common mode voltage independent of at least one of variations in supply voltage to the scalar circuit and variations to the scalar gain of the scalar circuit to provide the common mode voltage having linear direct current (DC) current-voltage characteristics to the motor for driving the motor.

7. A MEMS device, comprising:

a MEMS micro-mirror;

a motor coupled to a MEMS micro-mirror; and

a motor driver circuit, the motor driver circuit comprising:

a non-inverting buffer circuit;

an inverting buffer circuit; and

a scalar circuit, the scalar circuit comprising a VCMSC generation circuit,

wherein the non-inverting buffer circuit, the inverting buffer circuit, and the scalar circuit are configured, together with the VCMSC generation circuit, to provide a common mode voltage to a motor in response to a VCMSC voltage generated by the VCMSC generation circuit,

wherein the VCMSC voltage is generated by the VCMSC generation circuit in response to a control supply voltage and a driver supply voltage provided to the VCMSC generation circuit, and

wherein the VCMSC generation circuit comprises a first resistor bridge, a second resistor bridge, and a variable resistor bridge, wherein the first resistor bridge is coupled to the control supply voltage, the second resistor bridge is coupled to the driver supply voltage, and the variable resistor bridge is configured with the first and second resistor bridges to change the VCMSC voltage in response to a change in at least one of the control supply voltage and the driver supply voltage.

8. The MEMS device in accordance with claim 7, wherein the variable resistor bridge comprises binary weighted parallel resistors.

9. The MEMS device in accordance with claim 6, wherein the linear DC current-voltage characteristics comprise a programmable DC current-voltage slope, and wherein the VCMSC generation circuit is further configured to provide the common mode voltage having the programmable slope to the motor, the common mode voltage providing zero motor current to position the motor in a rest position in response to the control supply voltage being at its common mode.

10. The MEMS device in accordance with claim 8, wherein the binary weighted parallel resistors are configured to be controlled by a digital code.