C L A I M S

1. An electronic driving circuit (20) for a microfluidic device (1) having a number of electrodes (4,6), comprising a number of synchronized driving stages configured to generate a respective driving signal (V_1,V_2,V_3) for each electrode or group of electrodes of the number of electrodes (4,6);

the driving signals (V_1,V_2,V_3) having a desired amplitude, frequency and phase-shift,

wherein each driving stage includes a switching-mode amplifier stage (22) configured to receive a clock signal (CK) and a target signal (V_t) and to generate, at an output (Out) thereof, an output signal (V_{out}) defining the respective driving signal, the amplifier stage (22) comprising:

a switching module (23), coupled to a first internal node (N_1) and controlled by the clock signal (CK) for selectively bringing said first internal node (N_1) to a control signal (V_c); and

a filter module (25,26), coupled between the first internal node (N_1) and the output (Out) and configured to provide the output signal (V_{out});

characterized in that the amplifier stage (22) further comprises: a feedback module (29), coupled to a feedback input (IN_{fb}) of said driving stage, designed to receive a

feedback signal (V_{fb}) indicative of the value of the respective driving signal, and configured to: generate, as a function of the comparison between said feedback signal (V_{fb}) and said target signal (V_t), the control signal (V_c) for said switching module (23); and to feed-back the control signal (V_c) towards the switching module (23), to modulate the clock signal (CK) and define the output signal (V_{out}).

2. The circuit according to claim 1, wherein the clock signals (CK) of the amplifier stages (22) are designed to define the frequency and phase-shift of the respective driving signals (V_1,V_2,V_3); and the target signals (V_t) are designed to define the amplitude of the respective driving signals (V_1,V_2,V_3).

3. The circuit according to claim 1 or 2, wherein the feedback module (29) is configured to feed-back the control signal (V_c) towards the switching module (23), to amplitude-modulate the clock signal (CK), and thus define the amplitude of the output signal (V_{out}).

4. The circuit according to any of the preceding claims, wherein the filter module (25,26) includes a band-pass filter (25) configured to select an operating frequency of the output signal (V_{out}), and a blocking capacitor (26), at the output of the band-pass filter (25), configured to block any DC component.

5. The circuit according to any of the preceding claims, further including an offset generator (30), coupled to all the amplifier stages (22), configured to generate a unique offset voltage (V_{off}) that is injected at the output (Out) of said amplifier stages (22), to define a controlled DC offset value of the respective driving signals (V_1,V_2,V_3).

6. The circuit according to claim 5, further including an offset inductor (32) for each of the amplifier stages (22), the offset inductors (32) of the amplifier stages (22) having a first terminal in common, coupled to the output of the offset generator (30), and a second terminal coupled to the output (Out) of the respective amplifier stage (22).

7. The circuit according to any of the preceding claims, wherein the feedback module (29) includes: a filter-and-rectifier module (36-38), coupled to the feedback input (IN_{FB}) of the amplifier stage (22) and configured to provide a comparison signal (V_{FB}'), as a function of said feedback signal (V_{FB}); a subtraction unit (39), configured to receive the comparison signal (V_{FB}') and the target signal (V_t), to generate an error signal (V_e), based on the difference between the comparison signal (V_{FB}') and the target signal (V_t); and a voltage converter (40), coupled at the output of the subtraction unit (39)

and configured to generate the control signal (V_c) based on the error signal (V_e).

8. The circuit according to claim 7, wherein the filter-and-rectifier module (36-38) includes: a high-pass filter (36), coupled to the feedback input (IN_{FB}) of the amplifier stage (22); a rectifier (37), coupled to the output of the high-pass filter (36); and a low-pass filter (38), coupled to the output of the rectifier (37).

9. The circuit according to any of the preceding claims, wherein the switching module (23) of the amplifier stage (22) comprises:

a switching element (24), coupled between a reference terminal (GND) and the first internal node (N_1), and having a control terminal designed to receive the clock signal (CK); and

an impedance element (28), coupled between the first internal node (N_1) and a second internal node (N_2) designed to receive the control signal (V_c);

and wherein said feedback module (29) is connected between the feedback input (IN_{FB}) of said driving stage and the second internal node (N_2), and is configured to generate said control signal (V_c) on said second internal node (N_2).

10. The circuit according to claim 9, wherein said impedance element (28) includes an inductor element.

11. The circuit according to any of the preceding claims, wherein the microfluidic device (1) defines a non-linear variable impedance load for the electronic driving circuit (20).

12. The circuit according to any of the preceding claims, wherein the driving signals (V_1,V_2,V_3) are designed to generate dielectric fields at the electrodes (4,6) of the microfluidic device (1), as a function of the frequency, time-shift and amplitude of the driving signals (V_1,V_2,V_3).

13. The circuit according to claim 12, wherein said dielectric fields are dielectrophoretic fields.

14. The circuit according to claim 13, wherein said dielectrophoretic fields define closed dielectrophoretic potential cages (11), designed to trap one or more particles (8) immersed in a fluid contained in the microfluidic device (1).

15. The circuit according to any of the preceding claims, wherein the output (Out) of the amplifier stages (22) are designed to be coupled to respective contact pads (9a,9b,9c) of the microfluidic device (1), electrically contacting respective electrode or group of electrodes (4,6).

16. The circuit according to any of the preceding claims, wherein said feedback signal (V_{FB}) is designed to

be picked-up within said microfluidic device (1).

17. An automated analysis apparatus (50), configured to cooperate with the microfluidic device (1) to perform analysis and/or separation operation on one or more particles (8) immersed in a fluid contained in the microfluidic device (1); the automated analysis apparatus (50) including the electronic driving circuit (20) according to any of the preceding claims.

18. The apparatus according to claim 17, including a control unit (52), configured to control the driving circuit (20) and to provide the clock signals (CK) and target signals (V_t) to the amplifier stages (22) thereof.

19. A microfluidic device (1), configured to manipulate particles (8) immersed in a fluid, the microfluidic device (1) including the number of electrodes as an array (2) of electrodes or electrode groups (4) carried by a substrate (5), and a plate electrode (6), arranged suspended above the array (2), an analysis chamber (7) containing the fluid being defined between the array (2) and the plate electrode (6), the microfluidic device (1) being configured to be coupled with the electronic driving circuit (20) according to any of claims 1-16; wherein the driving signals (V_1,V_2,V_3) are designed to drive the plate electrode (6) and the electrodes or electrode groups (4) of the array (2), to generate dielectric fields

at the plate electrode (6) and at the electrodes or electrode groups (4) of the array (2), as a function of the frequency, time-shift and amplitude of the driving signals (V_1,V_2,V_3).