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(54) Titre : ETALONNAGE HYBRIDE DE SOURCES DE COURANT DESTINE A DES AFFICHEURS A TENSION POLARISEE PAR COURANT PROGRAMMES

(54) Title: HYBRID CALIBRATION OF CURRENT SOURCES FOR CURRENT BIASED VOLTAGE PROGRA MMED (CBVP) DISPLAYS

(57) Abrégé/Abstract:
What is disclosed are systems and methods of compensation of images produced by active matrix light emitting diode device (AMOLED) and other emissive displays. Anomalies in bias currents produced by current biasing circuits for driving current biased voltage programmed pixels are corrected through calibration and compensation while re-using existing data or other lines that can be controlled individually to perform said calibration and compensation.

ABSTRACT OF THE DISCLOSURE

What is disclosed are systems and methods of compensation of images produced by active matrix light emitting diode device (AMOLED) and other emissive displays. Anomalies in bias currents produced by current biasing circuits for driving current biased voltage programmed pixels are corrected through calibration and compensation while re-using existing data or other lines that can be controlled individually to perform said calibration and compensation.

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HYBRID CALIBRATION OF BIAS CURRENT

Revision: 1.0

I. Introduction

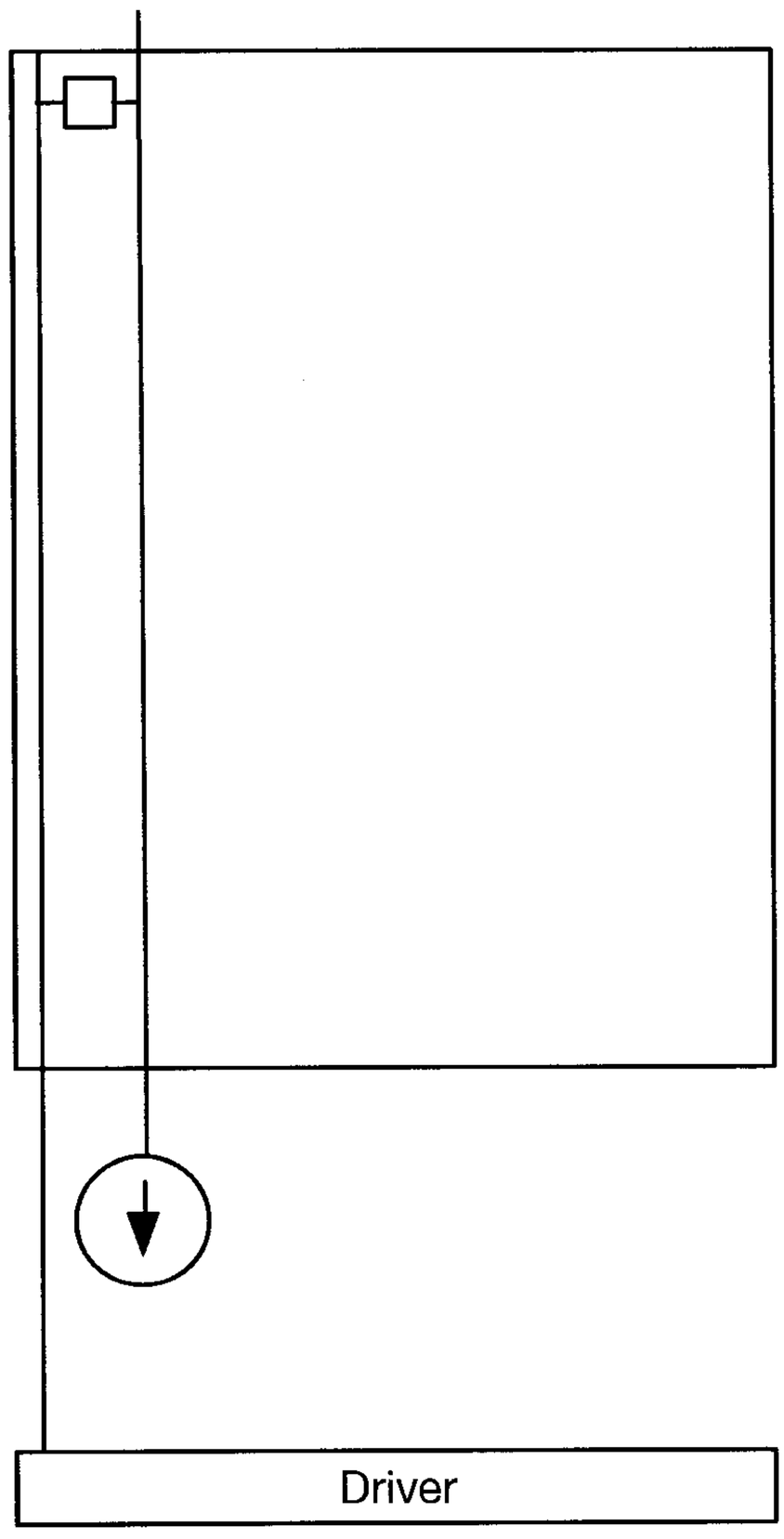


Figure 1: An embodiment of current-bias voltage-programmed (CBVP) display.

Figure 1 demonstrates an embodiment of current-bias voltage-programmed display. The pixel is biased with a current and programmed with video data through a driver. The main challenge is to have uniform current sources and lower cost and integrated into the display panel.

This document describe a family of current source and method of making them uniform using existing displays components.

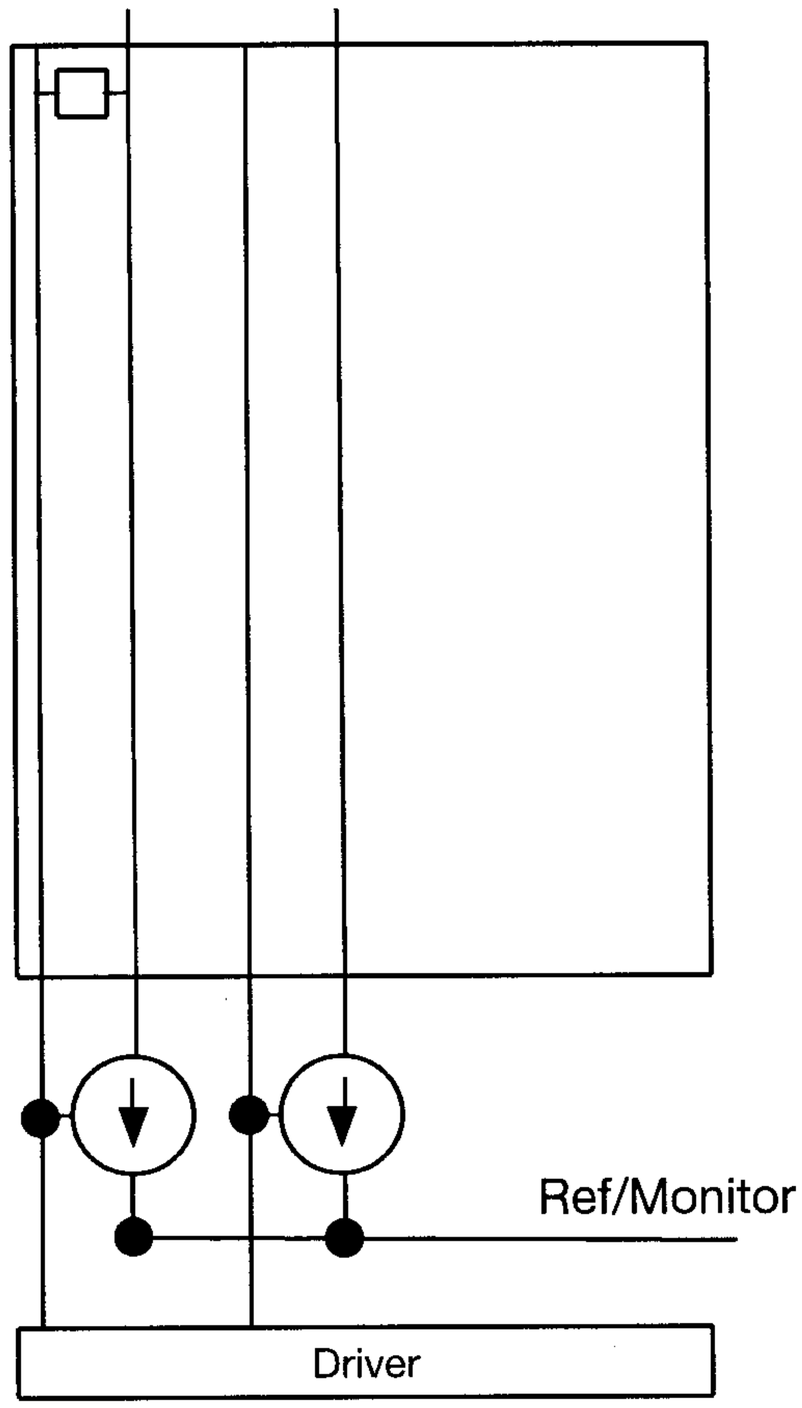


Figure 2: An embodiment of current-bias voltage-programmed (CBVP) display using display drivers to calibrate and control the current sources.

Here, the reference signal used to program (through voltage or reference current) is used to also measure the current of each current source. here the ref/monitor line is coupled to the source or drain of the transistor (or cascaded transistor structure). The gate of said transistor (or cascaded transistor structure) is coupled to the voltage (or current or charge) lines that can be controlled individually.

In one method, these lines can be connected to the source driver lines of the panel. As a result, the display timing controller program the display with one extra line.

One current sink based on this structure is demonstrated in Figure 3 based on PMOS transistors. Using similar principle one can easily make current source with PMOS transistor. These

structure can be easily replaced with different types of transistor (PMOS, NMOS or CMOS) and different semiconductor materials (e.g. LTPS, Metal Oxide, etc.).

During the programming, T3 connects the reference line (can be voltage or current) to the source of T1 and T2 connects a bias line to the gate of T1. As a result, the storage capacitance get charged to defined value. In one method, after programming the circuit is reconfigured to discharge some of the voltage (charge) stored in the at least one of the storage capacitor as a function of the main element of the current source (sink) T1 or its related components. The calibration time in the Figure 3(b) is for the discharge purpose. This can be also eliminated.

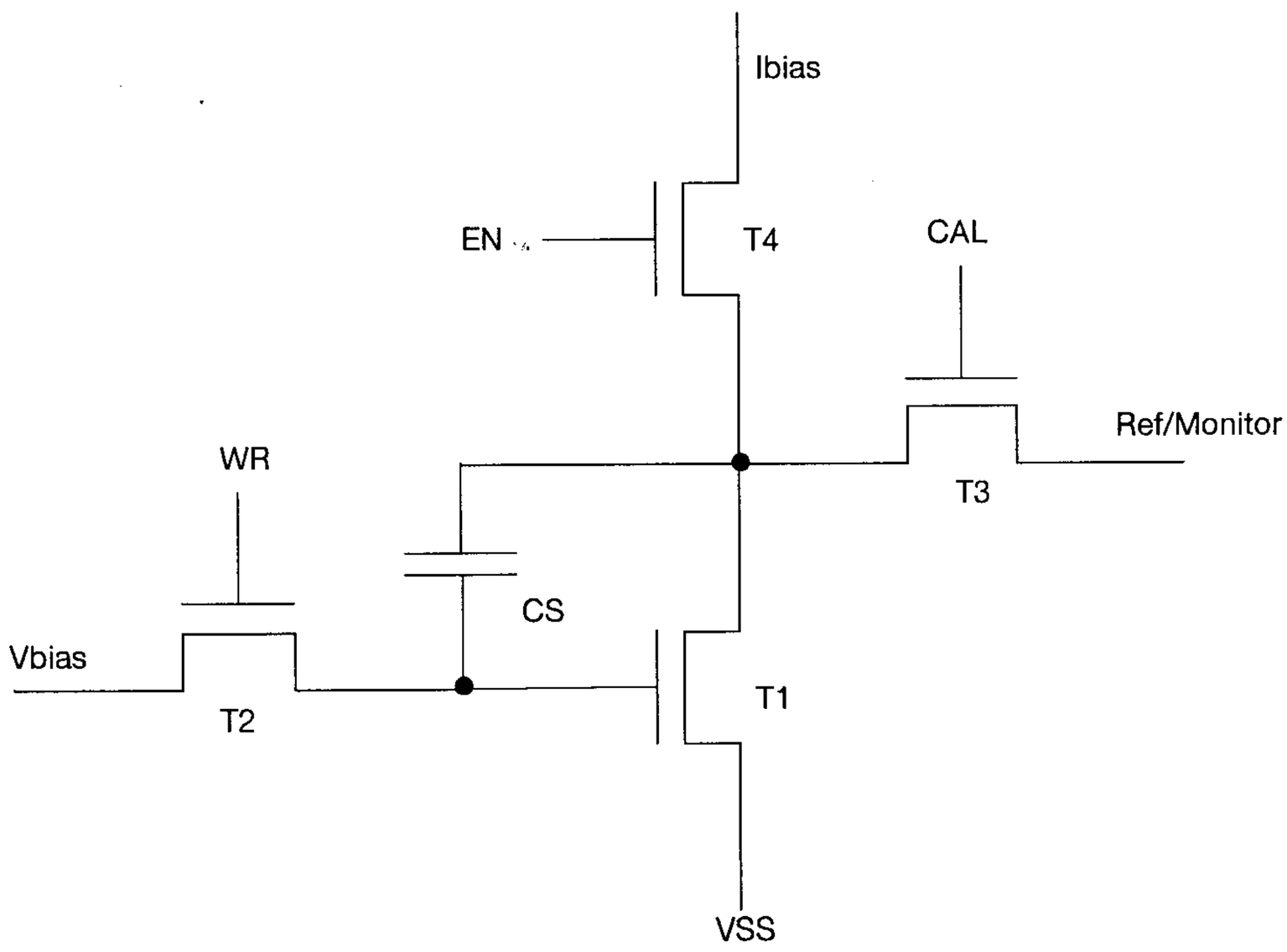


Figure 3(a): An embodiment of a current sink using PMOS transistors.

In another method, the output current of the current sink/source can be measured through the ref/ monitor line. Here, T3 turns ON and redirect the current to the ref/monitor line which can be measured outside. Since ref/monitor line can be shared between different current sink/source, during measurement all the embodiments are set to zero current except the one intended for the measurement.

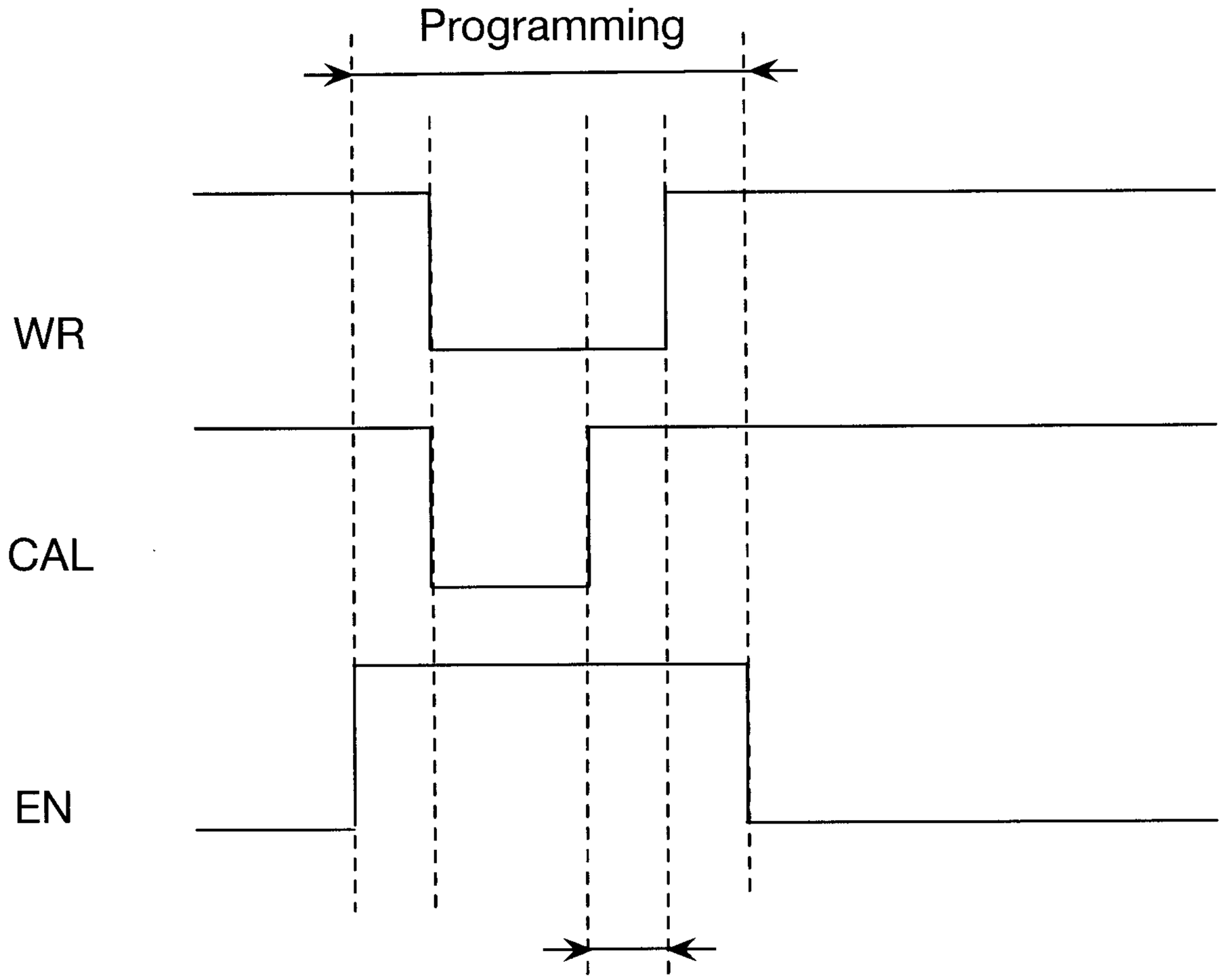


Figure 3(b): An example of timing for controlling the current sink.

Figure 4 shows an example of current source using PMOS transistors. similar timing as that shown in Figure 3(b) can be used for this embodiment as well.

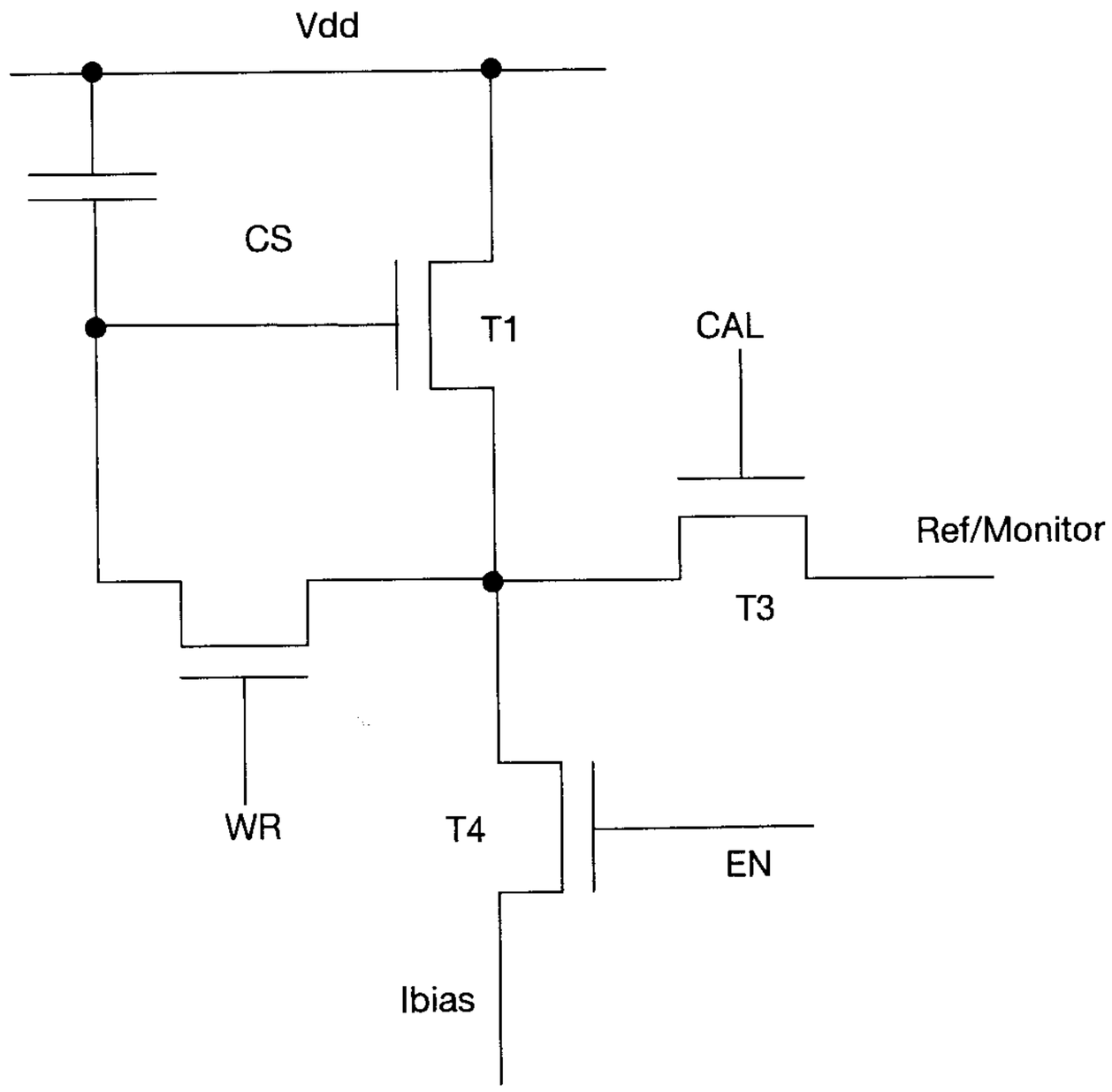


Figure 4: An embodiment of a current source using PMOS transistors.

WHAT IS CLAIMED IS:

1. A system for providing biasing currents to pixels of an emissive display system, each pixel having a light-emitting device, the system comprising:

a plurality of current biasing elements;

a plurality of current bias lines coupling said plurality of current biasing elements to said pixels; and

a controller coupled to said current biasing elements for controlling a programming of said current biasing elements over a plurality of signal lines;

wherein each current biasing element comprises:

at least one current driving transistor coupled to a current bias line for providing a biasing current over the current bias line; and

a storage capacitance for being programmed and for setting a magnitude of the biasing current provided by the at least one current driving transistor;

wherein the controller's controlling the programming of each current biasing element comprises:

during a programming cycle charging the storage capacitance to a defined level; and

subsequent to the programming cycle, during a calibration cycle, partially discharging the storage capacitance as a function of characteristics of the at least one driving transistor.

2. The system of claim 1, wherein the plurality of signal lines comprises a plurality of data lines coupling a source driver of the emissive display system to the pixels and for programming said pixels, the data lines for coupling the controller and the plurality of current biasing elements at times different from when the data lines couple the source driver to the pixels.

3. The system of claim 2, further comprising a reference monitor line shared by the plurality of current biasing elements and coupling the plurality of current biasing elements to the controller.

4. The system of claim 2 wherein each current biasing element is a current sink, wherein the at least one current driving transistor comprises a single current driving transistor, wherein the

storage capacitance is coupled across a gate of said current driving transistor and one of a source and drain of said current driving transistor, the other of said source and drain of said current driving transistor coupled to a voltage supply, wherein during the calibration cycle, the current driving transistor is allowed to partially discharge said storage capacitance through the current driving transistor to said voltage supply.

5. The system of claim 2 wherein each current biasing element is a current source, wherein the at least one current driving transistor comprises a single current driving transistor, wherein the storage capacitance is coupled across a gate of said current driving transistor and one of a source and drain of said current driving transistor, the one of said source and drain of said current driving transistor coupled to a voltage supply, wherein during the calibration cycle, the current driving transistor is allowed to partially discharge said storage capacitance through the current driving transistor to said voltage supply.

6. A system for providing biasing currents to pixels of an emissive display system, each pixel having a light-emitting device, the system comprising:

a plurality of current biasing elements;

a plurality of current bias lines coupling said plurality of current biasing elements to said pixels;

a controller coupled to said current biasing elements for controlling a programming of said current biasing elements over a plurality of signal lines; and

a monitor coupled to the plurality of current biasing elements for monitoring a biasing current produced by each current biasing element and for storing in a memory a measurement representing said biasing current for each current biasing element;

wherein each current biasing element comprises:

at least one current driving transistor coupled to a current bias line for providing a biasing current over the current bias line; and

a storage capacitance for being programmed and for setting a magnitude of the biasing current provided by the at least one current driving transistor;

wherein the controller's controlling the programming of each current biasing element comprises:

retrieving from said memory said measurement representing said biasing current for the current biasing element;

determining a deviation of said biasing current represented by said measurement from an expected biasing current; and

charging the storage capacitance to a defined compensated level which compensates for said deviation so that said current biasing element produces the expected biasing current.

7. The system of claim 6, wherein the plurality of signal lines comprises a plurality of data lines coupling a source driver of the emissive display system to the pixels and for programming said pixels, the data lines for coupling the controller and the plurality of current biasing elements at times different from when the data lines couple the source driver to the pixels.

8. The system of claim 6, further comprising a reference monitor line shared by the plurality of current biasing elements and coupling the plurality of current biasing elements to the controller, the controller coupled to the monitor.

9. A method of providing biasing currents to pixels of an emissive display system, each pixel having a light-emitting device, the emissive display system including a plurality of current biasing elements and a plurality of current bias lines coupling said plurality of current biasing elements to said pixels, each current biasing element including at least one current driving transistor coupled to a current bias line for providing a biasing current over the current bias line and a storage capacitance for being programmed and for setting a magnitude of the biasing current provided by the at least one current driving transistor, the method comprising:

programming each current biasing element over a plurality of signal lines comprising:

charging the storage capacitance to a defined level during a programming cycle; and

subsequent to the programming cycle, during a calibration cycle, partially discharging the storage capacitance as a function of characteristics of the at least one driving transistor.

10. The method of claim 9, wherein the plurality of signal lines comprises a plurality of data lines coupling a source driver of the emissive display system to the pixels and for programming said pixels, the data lines for coupling the controller and the plurality of current biasing elements for performing said programming each current biasing element at times different from when the data lines couple the source driver to the pixels.

11. The method of claim 10, wherein a reference monitor line is shared by the plurality of current biasing elements and wherein said charging said storage capacitance comprises coupling to the controller over said reference monitor line each current biasing element being charged while de-coupling from the controller current biasing elements not being charged.

12. The method of claim 10 wherein each current biasing element is a current sink, wherein the at least one current driving transistor comprises a single current driving transistor, wherein the storage capacitance is coupled across a gate of said current driving transistor and one of a source and drain of said current driving transistor, the other of said source and drain of said current driving transistor coupled to a voltage supply, wherein during the calibration cycle, partially discharging the storage capacitance comprises allowing the current driving transistor to partially discharge said storage capacitance through the current driving transistor to said voltage supply.

13. The method of claim 10 wherein each current biasing element is a current source, wherein the at least one current driving transistor comprises a single current driving transistor, wherein the storage capacitance is coupled across a gate of said current driving transistor and one of a source and drain of said current driving transistor, the one of said source and drain of said current driving transistor coupled to a voltage supply, wherein during the calibration cycle, partially discharging the storage capacitance comprises allowing the current driving transistor to partially discharge said storage capacitance through the current driving transistor to said voltage supply.

14. A method of providing biasing currents to pixels of an emissive display system, each pixel having a light-emitting device, the emissive display system including a plurality of current biasing elements, a plurality of current bias lines coupling said plurality of current biasing elements to said pixels, each current biasing element including at least one current driving transistor coupled to a current bias line for providing a biasing current over the current bias line and a storage capacitance for being programmed and for setting a magnitude of the biasing current provided by the at least one current driving transistor, the method comprising:

monitoring a biasing current produced by each current biasing element;

storing in a memory a measurement representing said biasing current for each current biasing element; and

programming each current biasing element over a plurality of signal lines comprising:

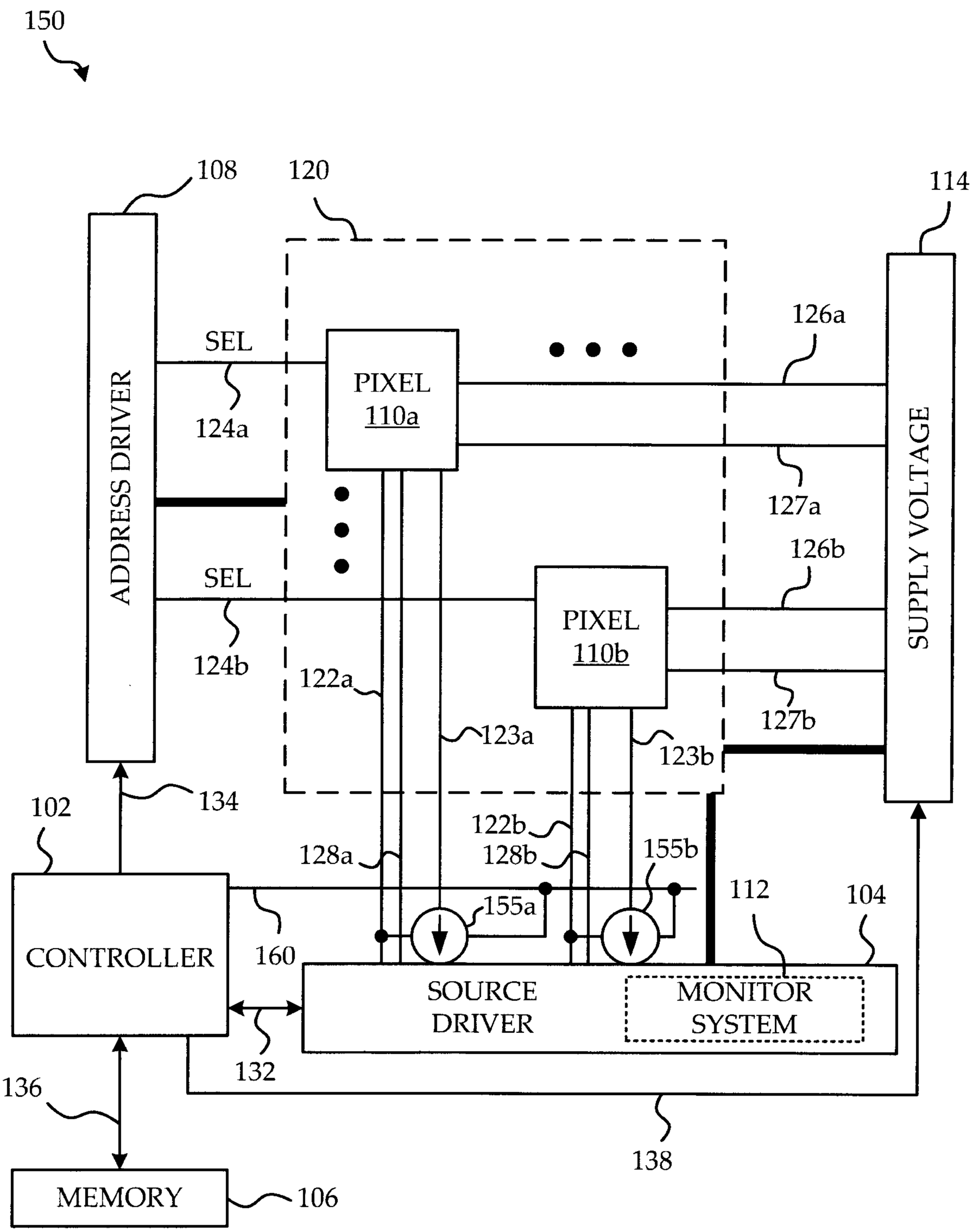
retrieving from said memory said measurement representing said biasing current for the current biasing element;

determining a deviation of said biasing current represented by said measurement from an expected biasing current; and

charging the storage capacitance to a defined compensated level which compensates for said deviation so that said current biasing element produces the expected biasing current.

15. The method of claim 14, wherein the plurality of signal lines comprises a plurality of data lines coupling a source driver of the emissive display system to the pixels and for programming said pixels, the data lines for coupling the controller and the plurality of current biasing elements for performing said programming each current biasing element at times different from when the data lines couple the source driver to the pixels.

16. The method of claim 14, wherein the controller is coupled to the monitor, a reference monitor line is shared by the plurality of current biasing elements and wherein said monitoring each current biasing element comprises coupling to the controller over the reference monitor line each current biasing element being measured while de-coupling from the controller current biasing elements not being measured.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120
114
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SEL
124a
PIXEL
110a
126a
127a
SUPPLY VOLTAGE
SEL
124b
122a
PIXEL
110b
126b
127b
123a
123b
134
102
122b
128a
128b
155b
155a
112
104
CONTROLLER
160
SOURCE
DRIVER
MONITOR
SYSTEM
132
136
138
MEMORY
106

FIG. 1

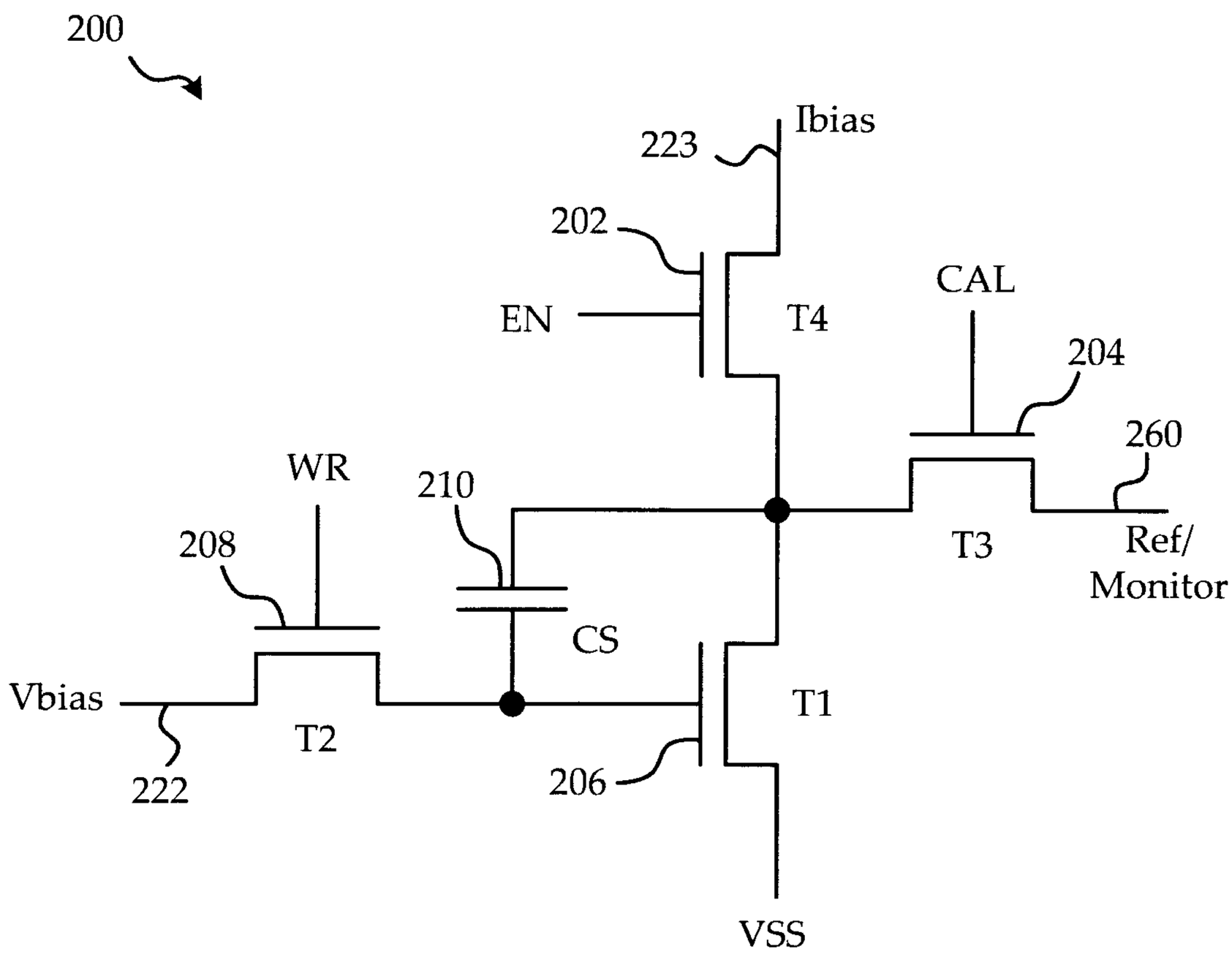
200
223
Ibias
202
EN
T4
CAL
204
260
WR
210
208
T3
Ref/
Monitor
CS
Vbias
T1
T2
206
222
VSS

FIG. 2

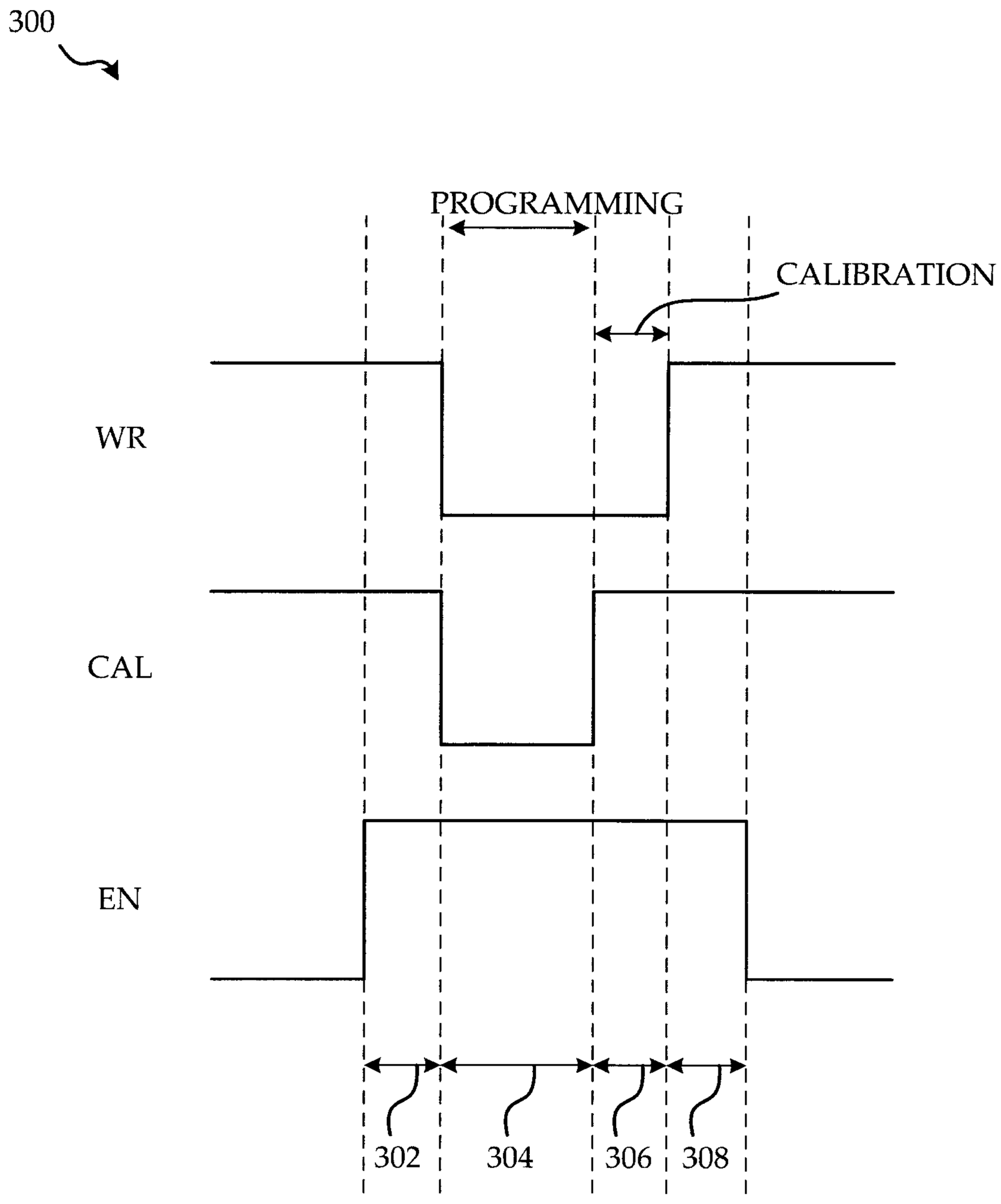

FIG. 3

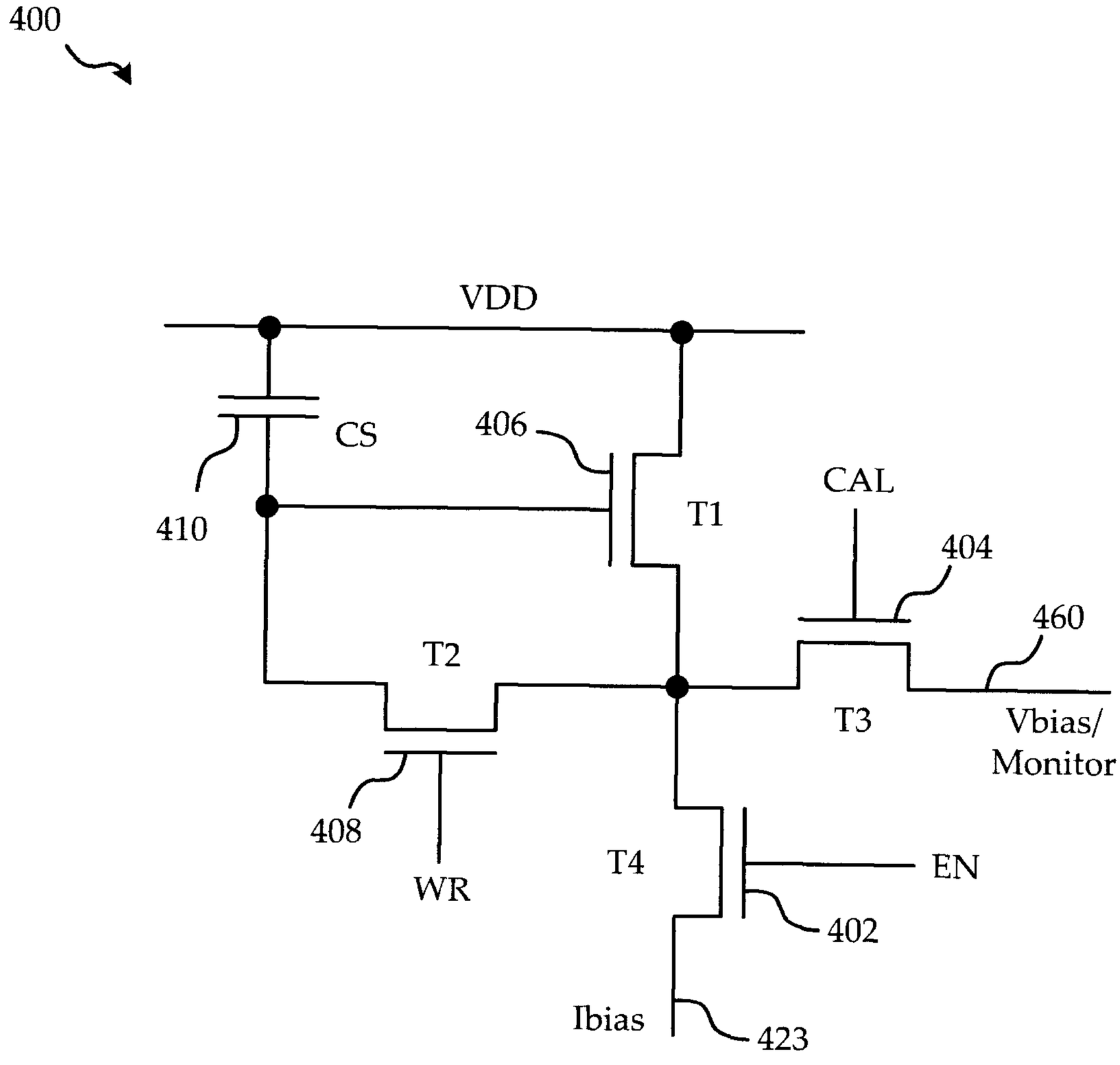
400
VDD
CS
406
410
T1
CAL
404
460
T2
T3
Vbias/
Monitor
408
WR
T4
EN
402
Ibias
423

FIG. 4