CMOS read-only electronic memory with static operation.

Priority: 20.10.87 IT 2233987

Date of publication of application:
26.04.89 Bulletin 89/17

Publication of the grant of the patent:
28.04.93 Bulletin 93/17

Designated Contracting States:
DE FR GB NL SE

References cited:
EP-A-0 020 054
EP-A-0 045 610

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Description

The present invention relates to an electronic solid-state read-only memory (ROM), particularly of the CMOS type, with static operation, i.e. with no need for a timing clock.

As is known, static read-only memories in CMOS technology are essentially constituted by a certain number of metallic and polycrystalline-silicon paths arranged in the form of crossing rows and columns, the columns being connected to respective pull-up elements, which in practice are transistors which always conduct between the columns and a supply voltage, and the rows leading to a decoder circuit which, driven by a required address, raises a single row to high voltage. In each crossing, the rows and the columns can be insulated or the column can be connected to the drain of a transistor (a pull-down transistor) having its source connected to the ground and its gate driven by the row. Therefore, when a given row is raised to high voltage by the decoder, the columns which it crosses are brought to ground voltage if the pull-down element is present, while they remain at high voltage if they are insulated. Therefore the presence of the pull-down transistor corresponds to a logical "0", while its absence corresponds to a "1".

The same structure as ROM memory is found in programmable logic arrays, or PLAs, which are distinguished by true ROM memories by the fact that in this case all the possible combinations of input to the decoder are not decoded. For the purposes of the invention, the term "read-only memory" will be used to refer both to ROM memories and to programmable logic arrays.

During the read of a given address of a ROM memory of this type, both the pull-up and the pull-down cells are activated, and a static current consumption is high, since each cell drains current thus flows from the supply voltage towards the ground. The read speed is therefore limited, and the current from the supply voltage.

In order to overcome the disadvantages of low speed and high consumption of static ROM memories, it is already known to provide dynamic ROM memories, in which the steps $\overline{0}_1$ and $\overline{0}_2$ of the clock are used to alternately activate the pull-up cells and the pull-down cells, so as to never have static current. The charge stored during the first step provides the current for the operation of the pull-down cells on the columns. However, if the memory is operated at low speed (i.e. if the clock frequency is low), it is necessary to provide a latch at the output to statically store the status of the columns during the second step, since the dispersion current can discharge the parasitic capacitor of the column.

Dynamic memory is faster than static memory and has a lower consumption, but it has the disadvantage that it requires the two clock steps $\overline{0}_1$ and $\overline{0}_2$, linked to the synchronism of the system, and that it furthermore requires a latch at its output.

The aim of the present invention is therefore to provide a ROM memory (or a PLA) which has the low consumption of dynamic memory and requiring neither clocks nor output latches.

This aim, together with other objects and advantages as will become apparent from the following description, is achieved by the invention with a read-only memory in CMOS technology, comprising a plurality of individually activatable rows and a plurality of main columns crossing said rows and connected, at each crossing corresponding to a logical "0", to a pull-down cell controlled by the crossed row line, each main column leading to the supply voltage through a respective pull-up transistor, characterized in that an auxiliary column is associated with each main column and is also connected to the supply voltage through a respective pull-up transistor, and is connected, at each crossing corresponding to a logical "1", to a pull-down cell controlled by the crossed row line, and in that the gates of the pull-up transistors of the main columns are connected to the auxiliary columns, and the gates of the pull-up transistors of the auxiliary columns are connected to the main columns.

A preferred embodiment of the invention is now described, given by way on non-limitative example with reference to the accompanying drawings, wherein:

Figure 1 is a partial circuit diagram of a CMOS read-only memory of the static type according to the prior art;
Figure 2 is a partial circuit diagram of a CMOS read-only memory of the dynamic type according to the prior art;
Figure 3 is a partial circuit circuit diagram of a CMOS read-only memory of the static type according to the invention.

In Figure 1, two columns $C_1$ and $C_2$ of a ROM memory in CMOS technology, of the static type, cross a generic row $R_n$. The complete memory comprises respective pluralities of rows and columns, which are not illustrated for the sake of simplicity.

Each column leads to drain of a respective PMOS transistor $P_1$ and $P_2$, each having its source connected to the positive supply voltage $V_{CC}$ and its gate connected to the ground. Therefore $P_1$ and $P_2$, as mentioned in the introduction, act as pull-up cells which keep the columns $C_1$ and $C_2$ high. The row $R_n$ is driven by the output of a decoder DEC, which raises it when a preset address is applied to its input in a per se known manner. At the crossing
between \( R_n \) and \( C_1 \) an NMOS transistor \( N_t \) has its drain connected to \( C_1 \), its drain connected to the ground and its gate connected to \( R_n \). No cell is connected at the crossing between \( R_n \) and \( C_2 \). Therefore, when \( R_n \) is active, the column \( C_1 \) is forced to the ground, providing a logical "0", while the column \( C_2 \) remains high, to provide a logical "1". In this manner the entire memory is programmed.

As mentioned, this type of memory absorbs a static current from \( V_c \), with high power consumption and low operating speed.

Figure 2 is similar to Figure 1, but refers to a ROM memory of the dynamic type, again according to the prior art. The transistors \( P_1 \) and \( P_2 \) are activated by a signal \( \phi_1 \), linked to the clock of the system, while the ROM cell \( N_t \) is connected to the ground through a further NMOS transistor \( N_X \), controlled by a signal \( \phi_2 \) in opposite phase with respect to \( \phi_1 \). In this manner, as mentioned, the columns \( C_1 \) and \( C_2 \) are raised only when they are insulated from the ground, and are thus pre-charged, while the read of the row \( R_n \) occurs when the columns are insulated from \( V_{cc} \), using the stored charge. Therefore there is no static current, power consumption is low and operating speed is high. However, the signals \( \phi_1 \) and \( \phi_2 \) are necessary, and furthermore, it is usually necessary to provide a latch at the output of the columns for a safe readout despite the dispersion of the charge from the columns.

Figure 3 is similar to Figures 1 and 2, but relates to a ROM memory in CMOS technology according to the invention. This execution again comprises rows \( R_n \) and columns \( C_1 \) and \( C_2 \), each leading to a pull-up transistor \( P_1 \) and \( P_2 \). A second auxiliary column \( CX_1 \) and \( CX_2 \) is arranged on the side of each column and is connected on one side to the gates of \( P_1 \) and \( P_2 \) and on the other side to \( V_{cc} \) through respective PMOS transistors \( PX_1 \) and \( PX_2 \), the gates whereof are respectively connected to \( C_1 \) and \( C_2 \).

The crossings between the (generic) row \( R_n \) and the respective pairs of columns \( C_1 \cdot CX_1 \) and \( C_2 \cdot CX_2 \), i.e., the individual cells, all have a respective NMOS pull-down transistor \( N_1 \) and \( N_2 \), with the gates driven by the row \( R_n \) and the drains connected to the ground. The drains of \( N_1 \) and of \( N_2 \) are respectively connected to the main column \( C_1 \) to generate a logical "0", and to the auxiliary column \( CX_1 \) to generate a logical "1".

The memory operates as explained hereafter. When the row \( R_n \) is activated, all the NMOS transistors are activated. \( C_1 \) reaches ground voltage, thus activating the pull-up transistor \( PX_1 \) and raising \( CX_1 \) to \( V_{cc} \). The transistor \( P_1 \) is thus switched "off", and the output of the column \( C_1 \) is statically low, since its pull-down \( N_1 \) is activated.

At the same time \( CX_2 \) is also brought to ground voltage, and thus activates the pull-up transistor \( P_2 \) of the column \( C_2 \), which switches "off" \( PX_2 \). The column \( C_2 \) thus remains statically high by virtue of \( P_2 \).

The circuit absorbs current only during switching, i.e., while the row passes from active to inactive, or vice versa, when the NMOS pull-down cells create a path towards the ground from the pull-up transistors which are active at that moment. Once the main and auxiliary columns \( C \) and \( CX \) have reached their final state, there is no longer any static current, since a single PMOS or NMOS transistor is active for each column, but never both. Since each column is connected either to \( V_{cc} \) or to the ground through an active transistor, there is no problem of dispersion.

Consumption is practically nil, similarly to the consumption of dynamic memory, with the advantage of eliminating the clock and the latch. The added auxiliary column is a negligible burden in comparison to said advantages.

The operating speed and the simplicity of the design are similar to those of static memory. Furthermore, the programming of the memory depends only on a metallic connection from the drain of the pull-down cell to one or the other of the two columns, main and auxiliary. Reprogramming is therefore easier than in the conventional solution, since it involves a simple metallic contact and not an active semiconductor area.

A preferred embodiment of the invention has been described, but it is understood that it is susceptible to equivalent modifications and variations on the part of the expert in the field, according to the given teachings, without thereby abandoning the scope of the inventive concept.

**Claims**

1. Read-only memory in CMOS technology, comprising a plurality of individually activatable rows (\( R_n \)) and a plurality of main columns (\( C_1, C_2 \)) crossing said rows and connected, at each crossing corresponding to a logical "0", to a pull-down cell (\( N_t \)) controlled by the crossed row line, each main column leading to the supply voltage through a respective pull-up transistor (\( P_1, P_2 \)), characterized in that an auxiliary column (\( CX_1, CX_2 \)) is associated with each main column and is also connected to the supply voltage through a respective pull-up transistor (\( PX_1, PX_2 \)), and is connected, at each crossing corresponding to a logical "1", to a pull-down cell (\( N_2 \)) controlled by the crossed row line, and in that the gates of the pull-up transistors of the main columns are connected to the auxiliary columns, and the
gates of the pull-up transistors of the auxiliary columns are connected to the main columns.

2. Read-only memory in CMOS technology, according to claim 1, characterized in that said supply voltage is positive and said pull-up transistors are transistors of the PMOS type.

3. Read-only memory in CMOS technology, according to claim 2, characterized in that said pull-down cells for the main columns and for the auxiliary columns are of the NMOS type.

Patentansprüche

1. Nur-Lesespeicher in CMOS-Technologie, umfassend eine Mehrzahl von einzelnen aktivierbaren Zeilen (Rn), und eine Mehrzahl von Hauptspalten (C1, C2), die die genannten Zeilen kreuzen und an jeder Kreuzung entsprechend einer logischen "0" mit einer Niederzbieh-Zelle (N1) verbunden sind, die durch die gekreuerte Zeilenleitung gesteuert wird, wobei jede Hauptspalte über einen entsprechenden Hochzbieh-Transistor (P1, P2) zu der Speisespannung leitet, dadurch gekennzeichnet, daß eine Hilfspalte (CX1, CX2) mit jeder Hauptspalte verbunden ist und auch mit der Speisespannung über einen entsprechenden Hochzbieh-Transistor (PX1, PX2) verbunden ist, und an jeder Kreuzung entsprechend einer logischen "1" mit einer Niederzbieh-Zelle (N2) verbunden ist, die durch die überkreuzte Zeilenleitung gesteuert wird, und daß die Gates der Hochzbieh-Transistoren der Hauptspalten mit den Hilfspalten verbunden sind und die Gates der Hochzbieh-Transistoren der Hilfspalten mit den Hauptspalten verbunden sind.

2. Nur-Lesespeicher in CMOS-Technologie gemäß Anspruch 1, dadurch gekennzeichnet, daß die genannte Speisespannung positiv und die genannten Hochzbieh-Transistoren Transistoren vom PMOS-Typ sind.

3. Nur-Lesespeicher in CMOS-Technologie gemäß Anspruch 2, dadurch gekennzeichnet, daß die genannten Niederzbieh-Zellen für die Hauptspalten und für die Hilfspalten vom NMOS-Typ sind.

Revendications

1. Mémoire en technologie CMOS comprenant une pluralité de rangées (Rn) individuellement activables et une pluralité de colonnes principales (C1, C2) croisant ces rangées et connectées, à chaque croisement correspondant à un "0" logique, à une cellule (N1) de tirage vers le bas commandée par la ligne de rangée croisée, chaque colonne principale conduisant à la tension d'alimentation par l'intermédiaire d'un transistor respectif de tirage vers le haut (P1, P2), caractérisée en ce qu'une colonne auxiliaire (CX1, CX2) est associée à chaque colonne principale et est également connectée à la tension d'alimentation par l'intermédiaire d'un transistor respectif (PX1, PX2) de tirage vers le haut et est connectée, à chaque croisement correspondant à un "1" logique, à une cellule de tirage vers le bas (N2) commandée par la ligne de rangée croisée, et en ce que les grilles des transistors de tirage vers le haut des colonnes principales sont connectées aux colonnes auxiliaires et les grilles des transistors de tirage vers le haut des colonnes auxiliaires sont connectées aux colonnes principales.

2. Mémoire en technologie CMOS selon la revendication 1, caractérisée en ce que la tension d'alimentation est positive et les transistors de tirage vers le haut sont des transistors de type PMOS.

3. Mémoire en technologie CAS selon la revendication 2, caractérisée en ce que les cellules de tirage vers le bas pour les colonnes principales et pour les colonnes auxiliaires sont du type NMOS.