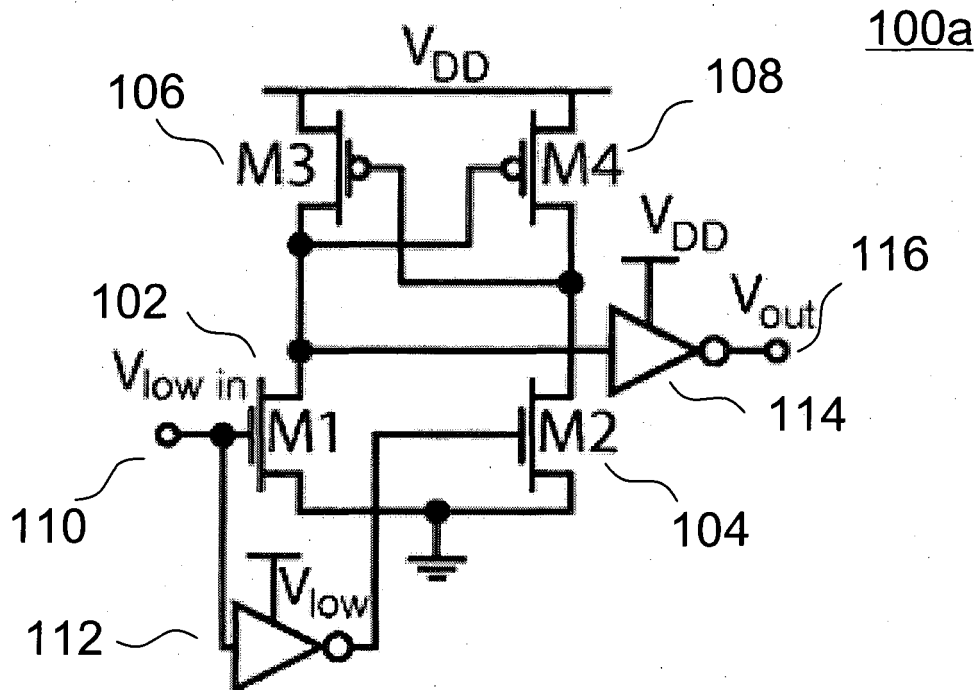


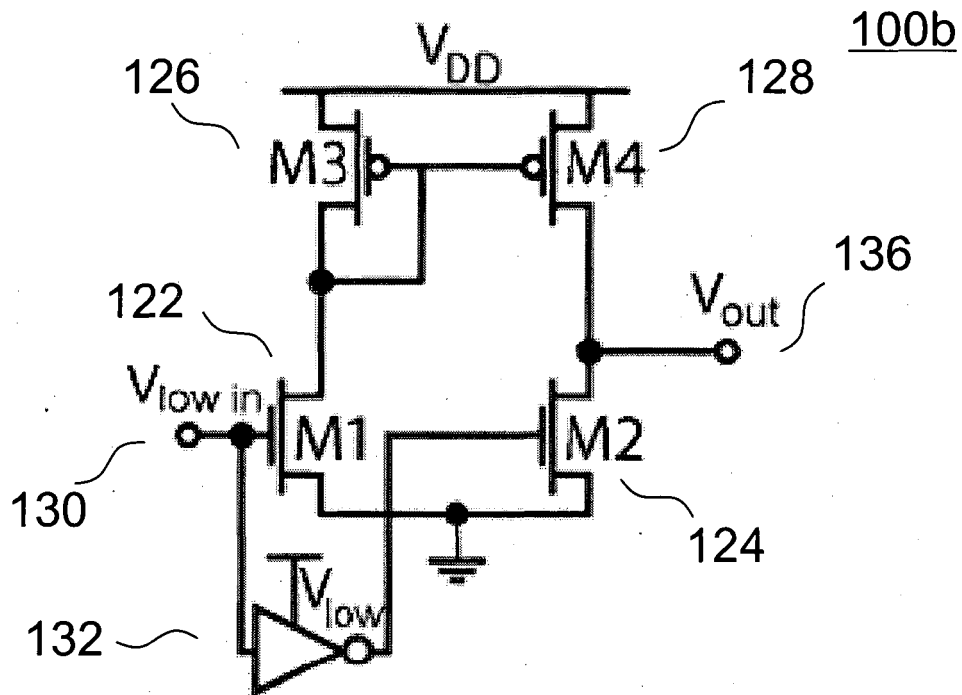
1/14

FIG. 1A



PRIOR ART

FIG. 1B



PRIOR ART

FIG. 2

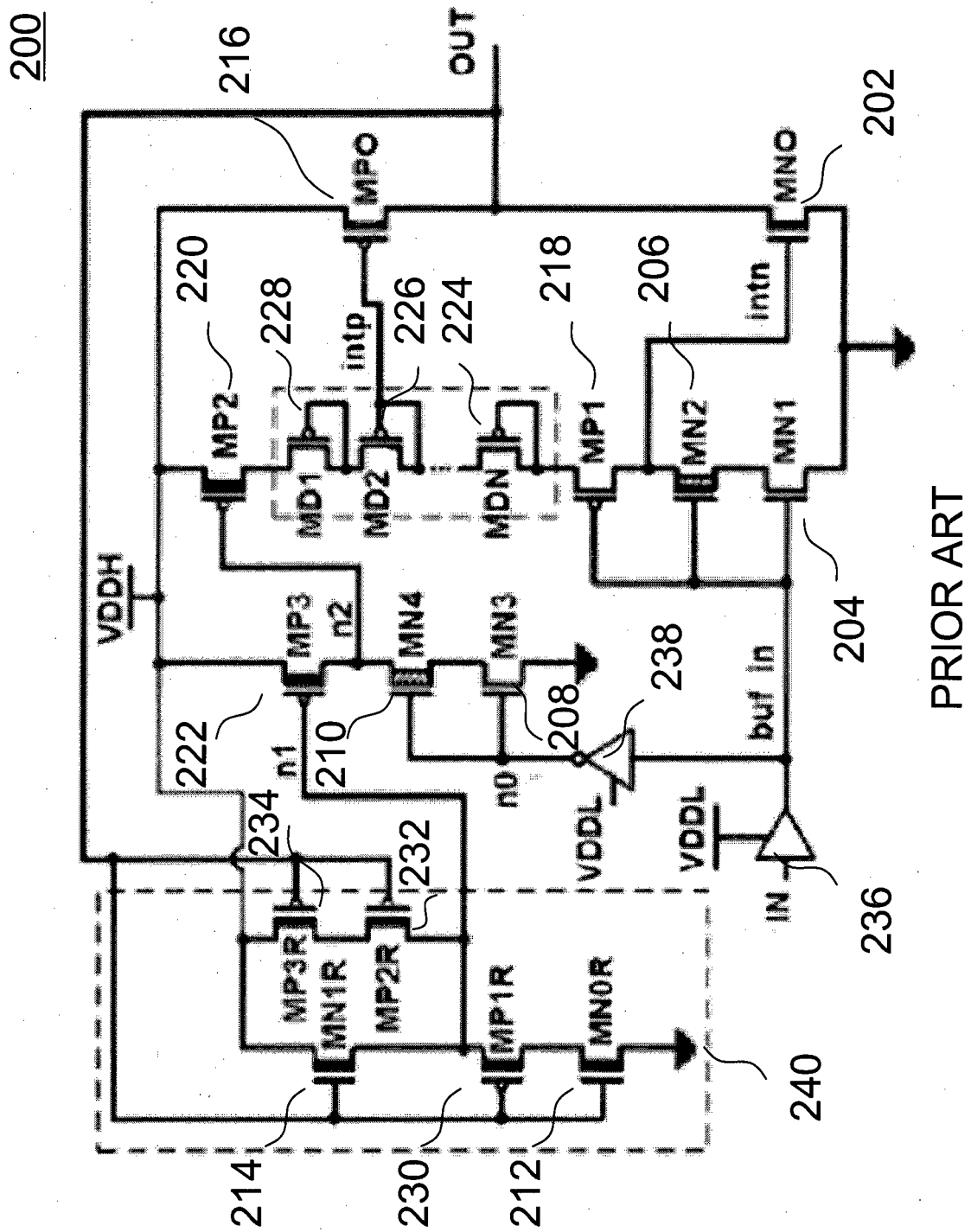
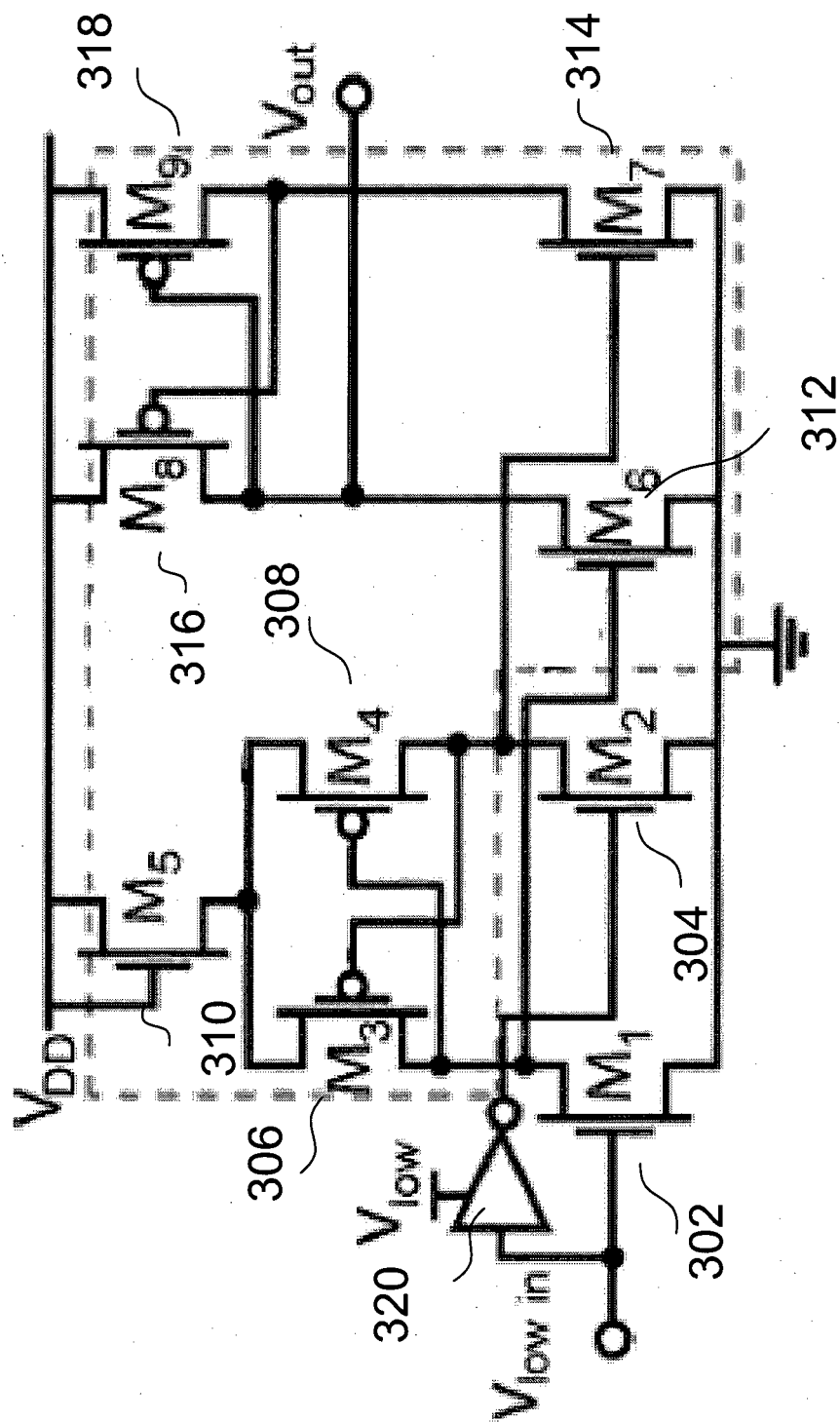


FIG. 3

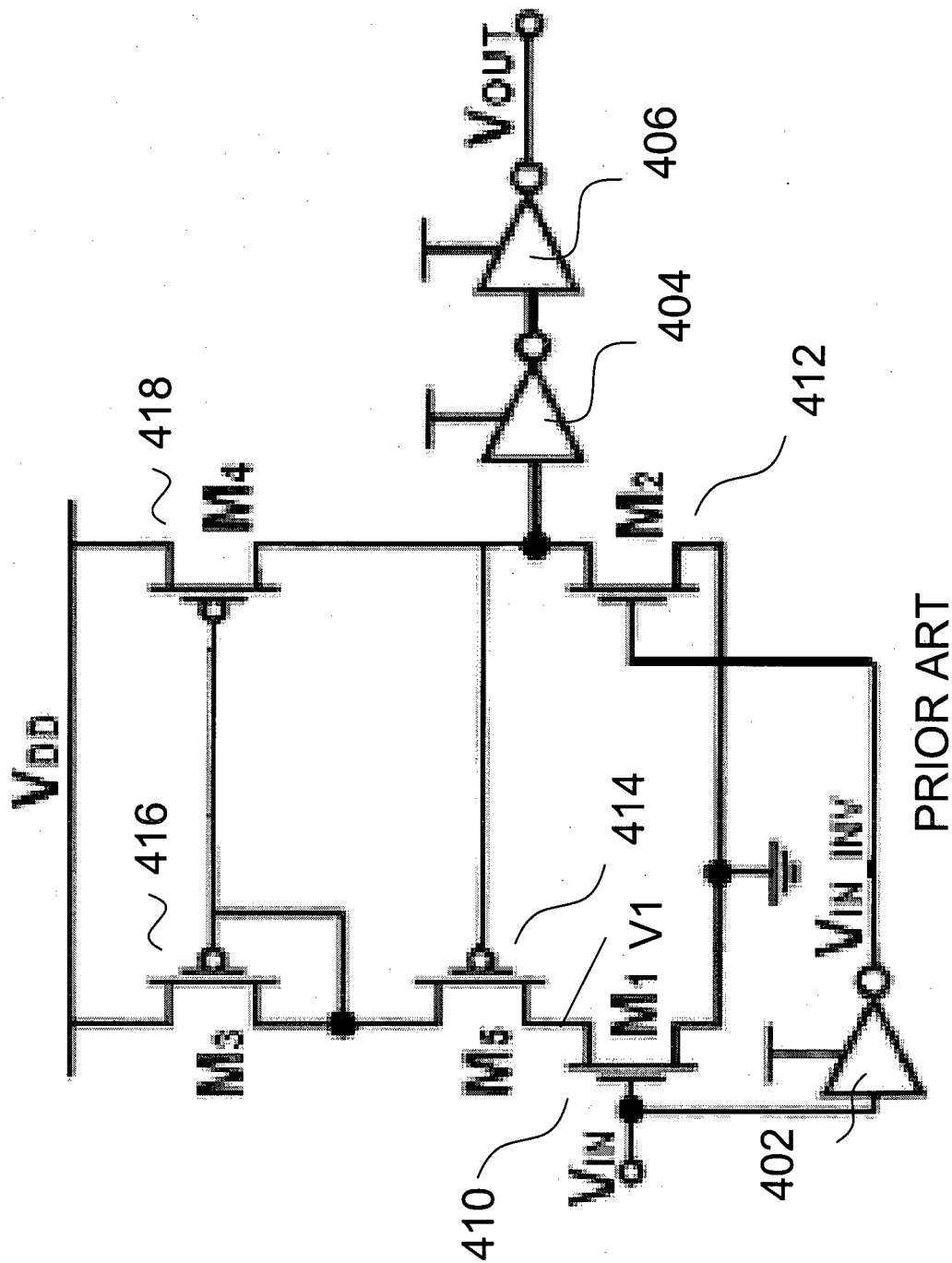
300



PRIOR ART

FIG. 4

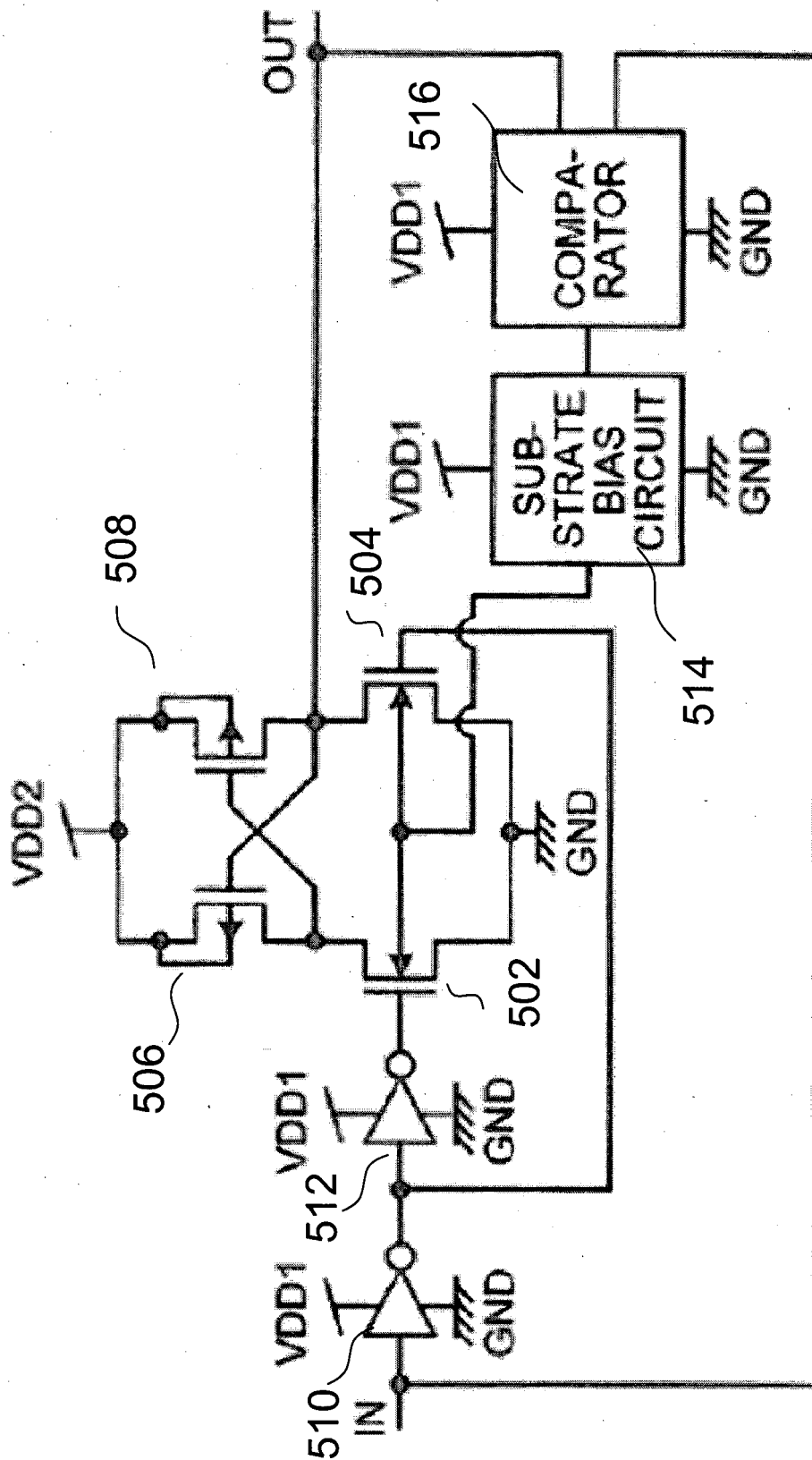
400



PRIOR ART

FIG. 5

500



PRIOR ART

FIG. 6

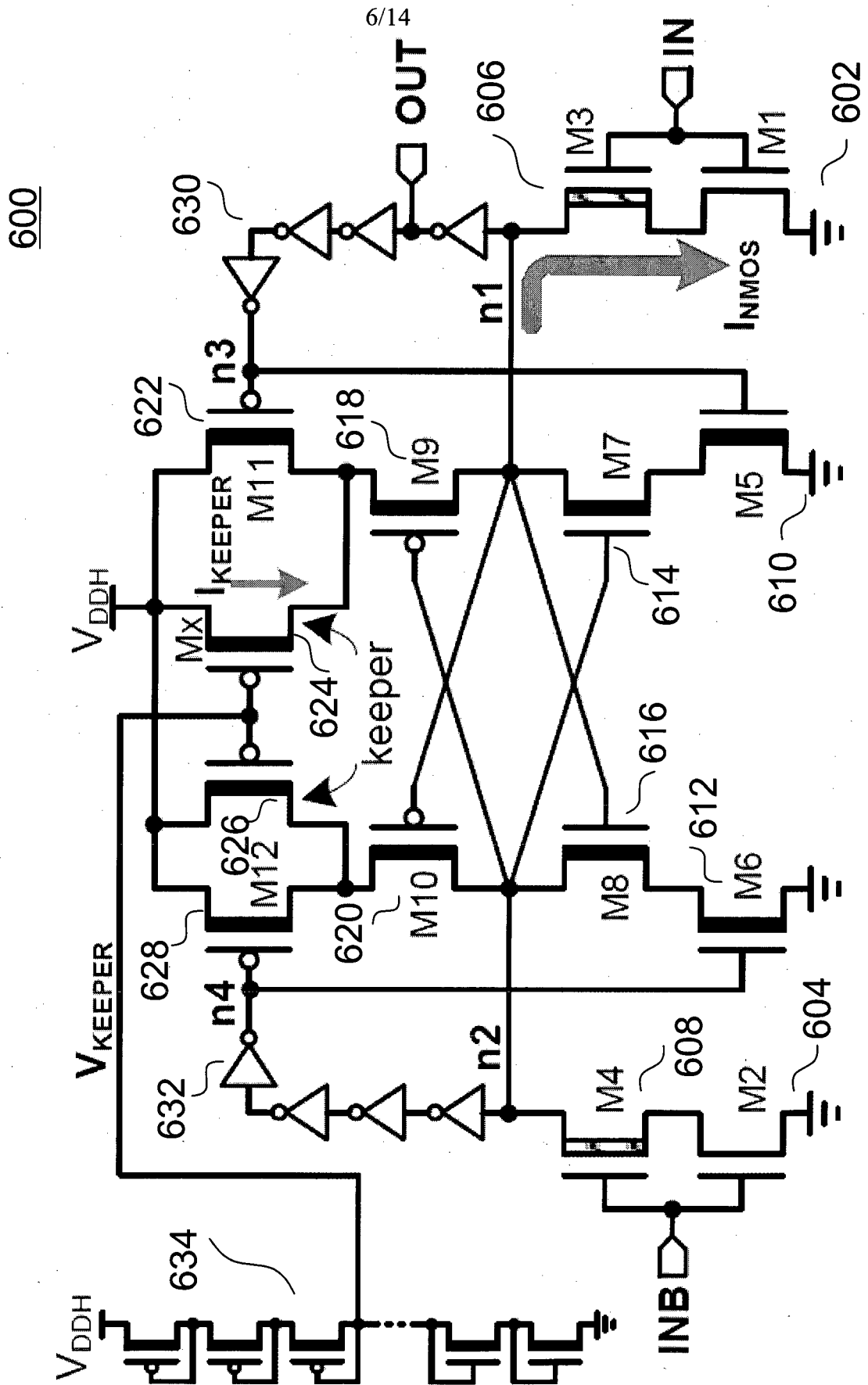
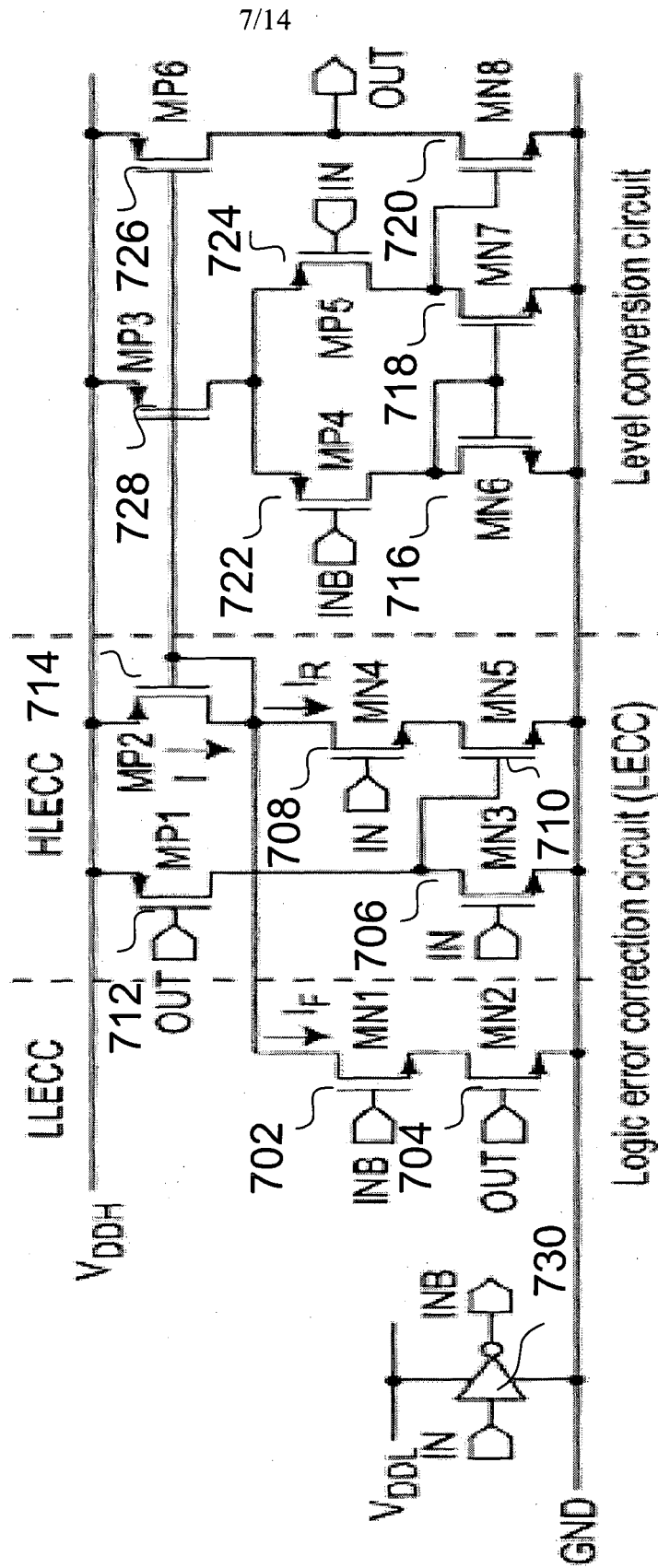


FIG. 7

700



8/14

FIG. 8

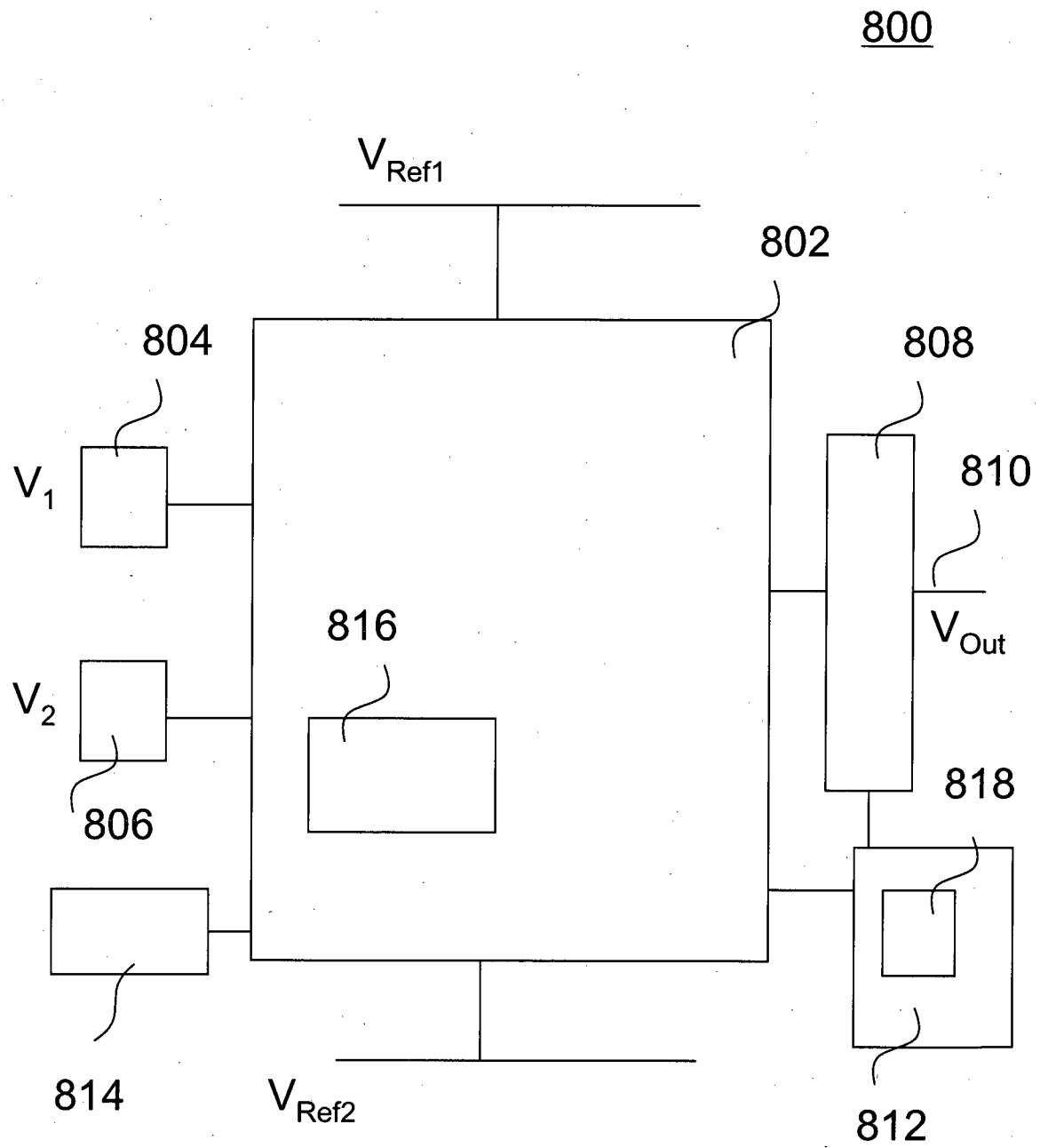
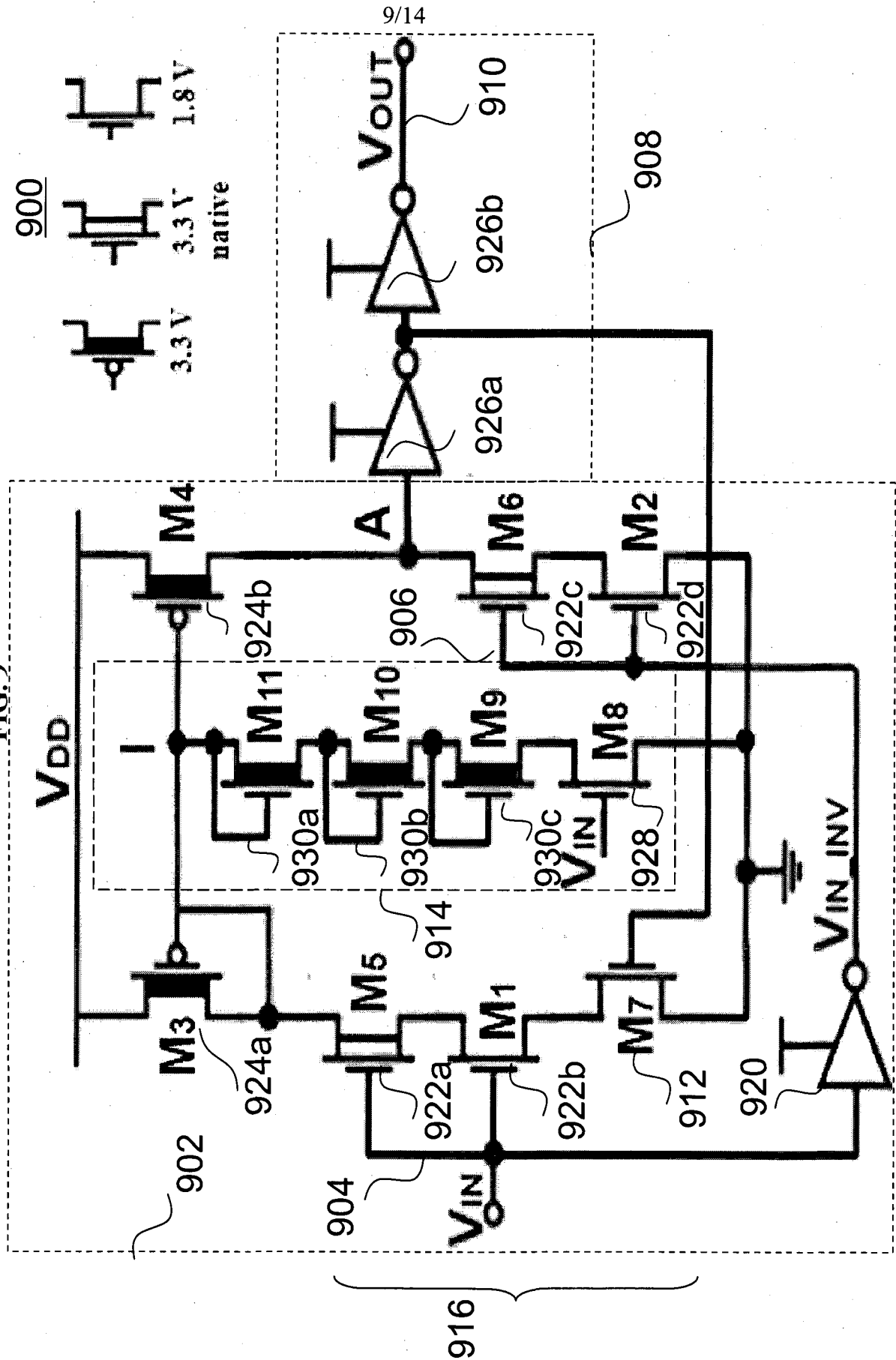


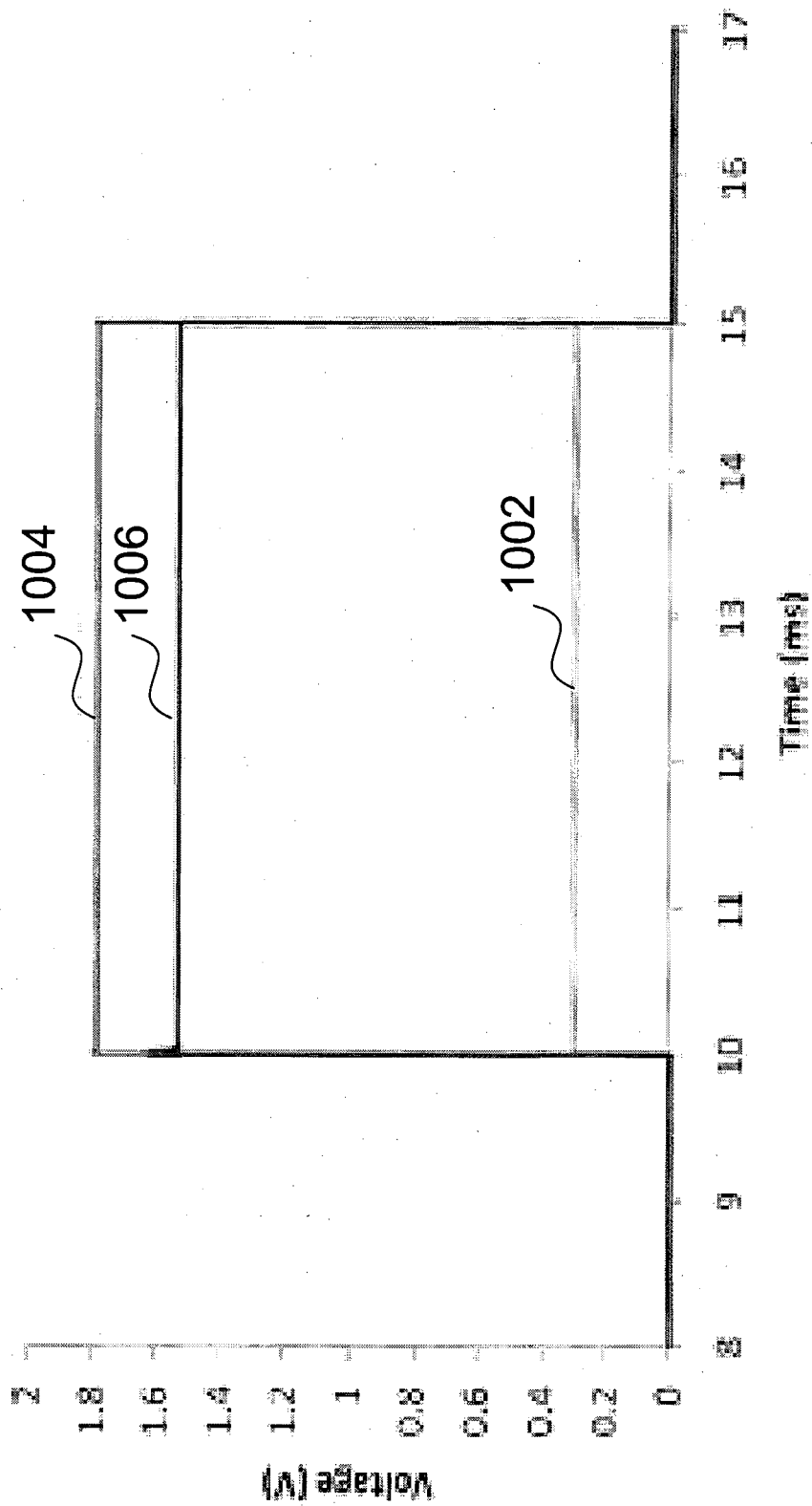
FIG. 9



10/14

FIG. 10

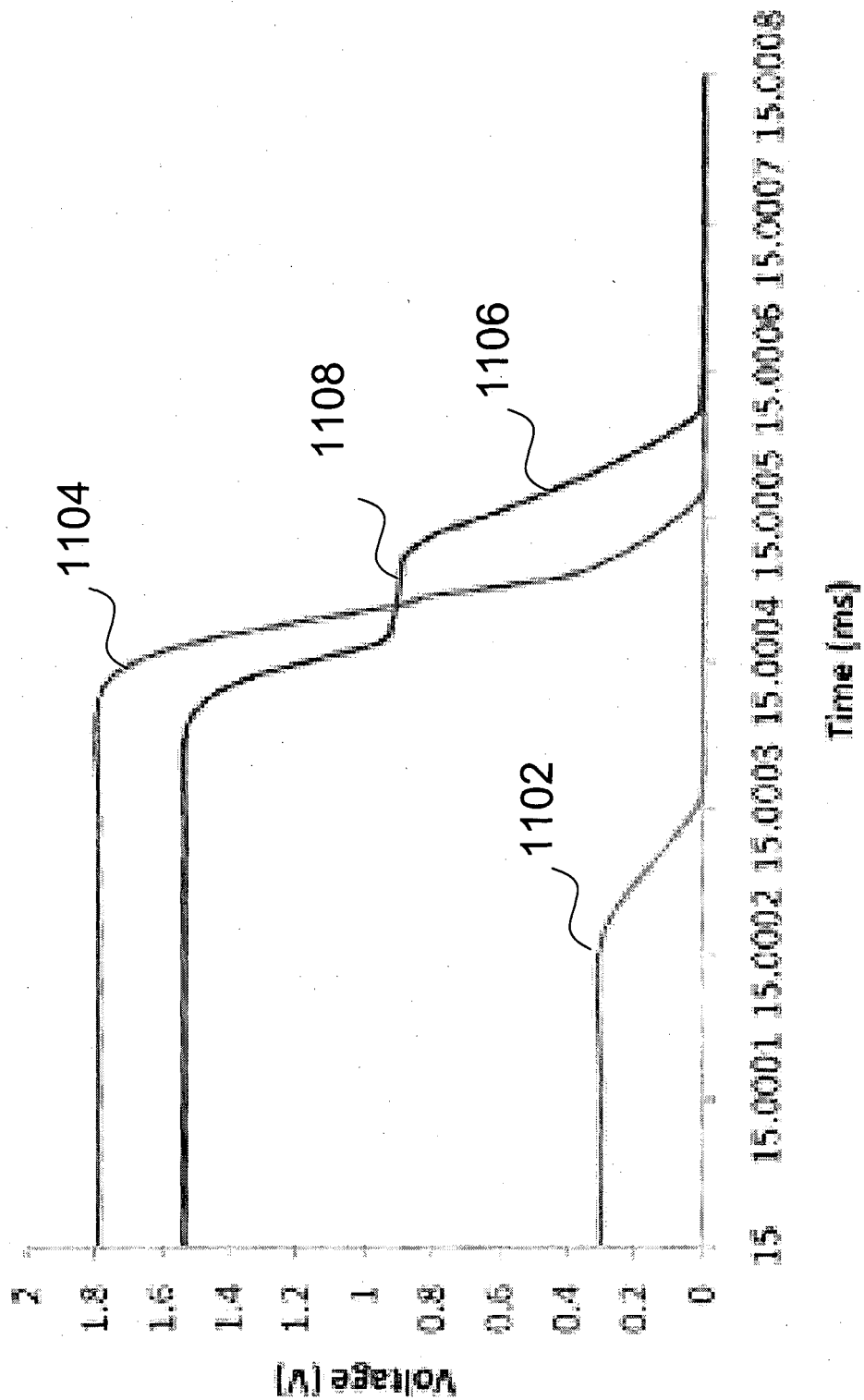
1000



11/14

FIG. 11

1100



12/14

FIG. 12

1102 1104 1106 1200

VDD (V)	LS from [4]			Proposed LS		
	Delay (ns)	Active Energy (fJ)	Leakage Power (pW)	Delay (ns)	Active Energy (fJ)	Leakage Power (pW)
0.6	1041	2	421	350	2	27
0.8	339	30	717	186	4	42
1.0	214	139	1112	157	5	57
1.2	178	354	1624	147	7	72
1.4	168	714	2269	145	10	90
1.6	171	1765	3066	145	17	111
1.8	197	2937	4034	146	36	135
2.0				146	58	168
2.5				147	174	297
3				151	515	507
3.3				164	891	842

FIG. 13

1300

13/14

Parameters	FIG.3	FIG.6	FIG.7	FIG.4	FIG.9
Process Technology	130 nm	130 nm	0.35 μ m	0.18 μ m (Re-implemented at 0.18 μ m for comparison)	0.18 μ m
Shifting Range	0.19 V - 1.2 V	0.3 V - 2.5 V	0.23 V - 3 V	0.2 V - 1.8 V	0.2 V - 3.3 V
Delay	10 FO4 (0.3 V $\rightarrow$ 1.2 V)	2.38 FO4 (0.3 V $\rightarrow$ 2.5 V)	10,000 ns (0.4 V $\rightarrow$ 3V) (FO4 delay not shown in the paper)	1.23 FO4 (0.3 V $\rightarrow$ 1.8 V)	1.02 FO4 (0.3 V $\rightarrow$ 3.3 V) 0.92 FO4 (0.3 V $\rightarrow$ 2.5 V) 0.92 FO4 (0.3 V $\rightarrow$ 1.8 V)
Active Energy Per Transition	Not shown	229 fJ (0.3 V $\rightarrow$ 2.5 V)	5,800 fJ (0.4 V $\rightarrow$ 3V)	2,937 fJ (0.3 V $\rightarrow$ 1.8 V)	891 fJ (0.3 V $\rightarrow$ 3.3 V) 174 fJ (0.3 V $\rightarrow$ 2.5 V) 36 fJ (0.3 V $\rightarrow$ 1.8 V)
Leakage Power	Not shown	475 pW (0.3 V $\rightarrow$ 2.5 V)	230 pW (0.4 V $\rightarrow$ 3V)	4,034 pW (0.3 V $\rightarrow$ 1.8 V)	842 pW @ 3.3 V 297 pW @ 2.5 V 135 pW @ 1.8 V
Delay with 3 σ PVT Variation	Not shown	4.76 FO4 (0.3 V $\rightarrow$ 2.5 V)	Not shown	3.14 FO4 (0.3 V $\rightarrow$ 1.8 V)	2.31 FO4 (0.3 V $\rightarrow$ 3.3 V) 2.19 FO4 (0.3 V $\rightarrow$ 2.5 V) 2.27 FO4 (0.3 V $\rightarrow$ 1.8 V)

14/14

FIG. 14

1400

couple a level shifting stage to a first reference voltage and a second reference voltage.

1402

couple a first input voltage to a first input electrode in electrical connection with the level shifting stage

1404

couple a second input voltage to a second input electrode in electrical connection with the level shifting stage

1406