

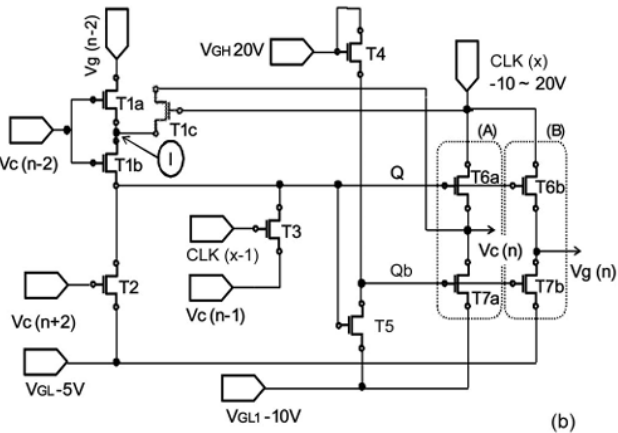
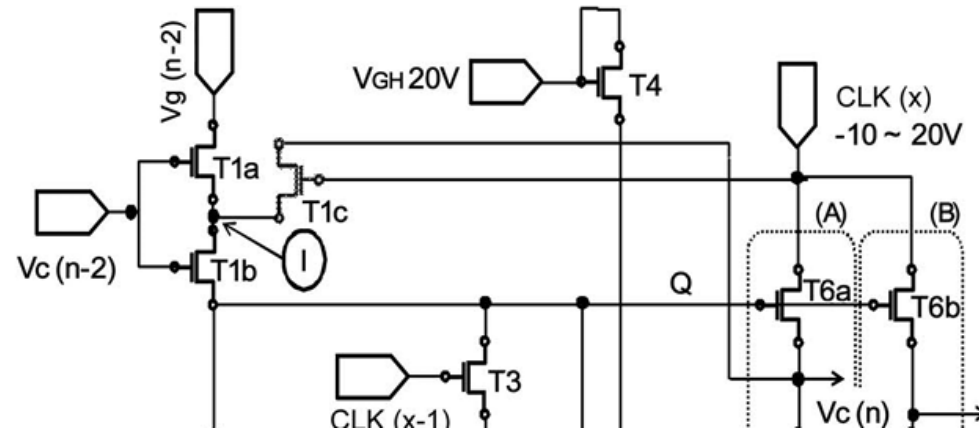
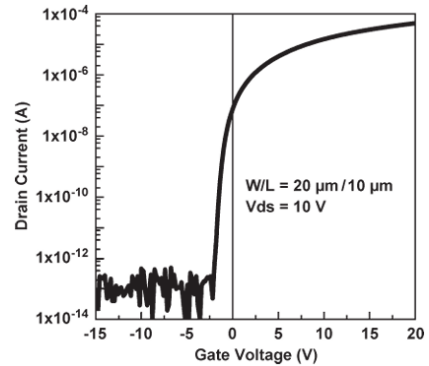
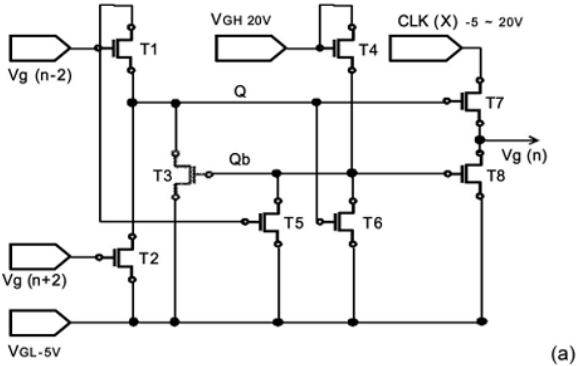


# 2011. EDL

Binn Kim, Chang-Il Ryoo, Sun-Jae Kim, Jong-Uk Bae, Hyun-Sik Seo, Chang-Dong Kim, and Min-Koo Han, SNU&LGdisplay

## New Depletion-Mode IGZO TFT Shift Register

### Conventional



$V_c(n-2)$ 가 입력 될 때 Q가 충전되며 T6a, T6b가 on 이 됨. 이 때 CLK(x)는 L.  
 이어서 CLK(x)가 H가 되면서 출력이 H가 되고 Q는 부트스트래핑 되어 전압 증가. 이 때 T1b를 오프 시키기 위하여 T1c를 통해 H를 1에 입력.  $V_c(n-2)$ 는 -10V,  $V_g(n-2)$ 는 -5V 이어서 T1a, T1b 모두 오프가 됨.

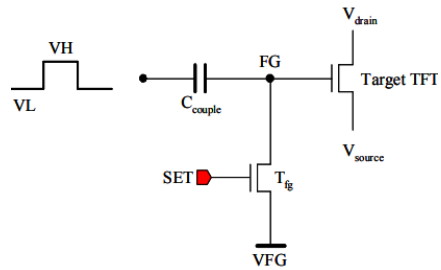
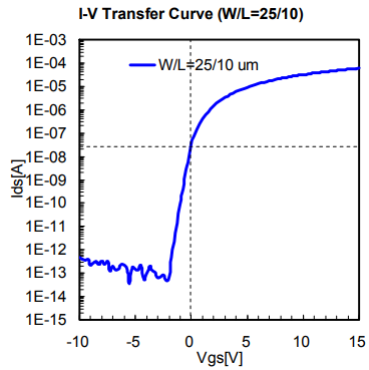
### Proposed

VSS: -5, -10 두 전원 사용

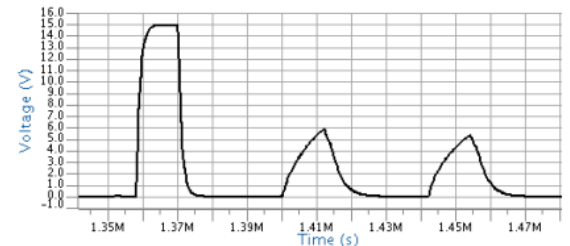
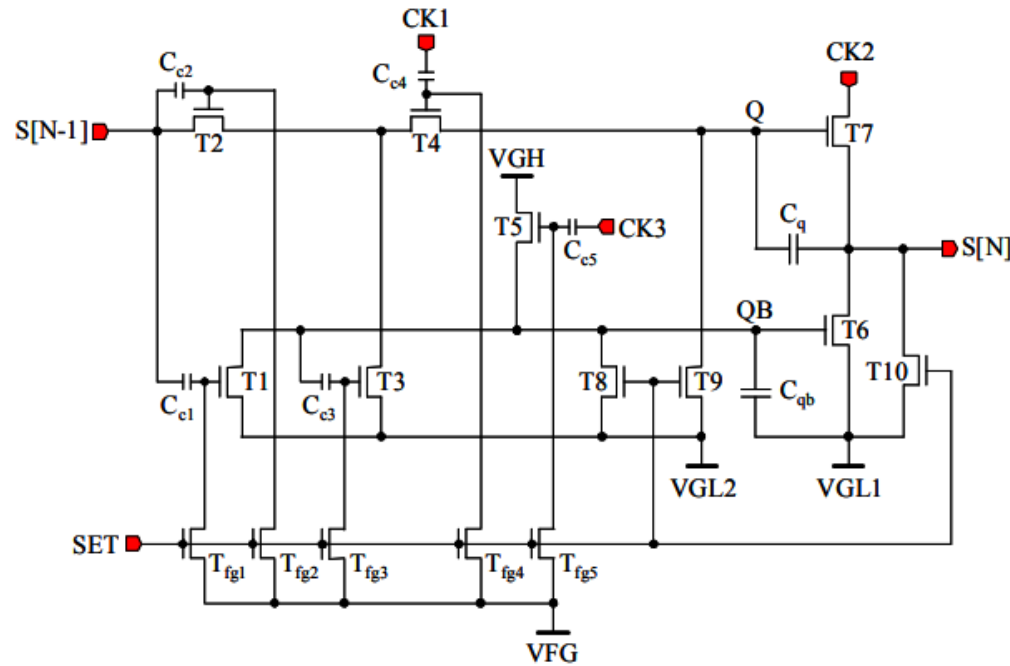
2011 SID

Chul-Kyu Kang, Yong-Sung Park, Seong-II Park, Yeon-Gon Mo, Byung-Hee Kim, and Sang Soo Kim, Samsung

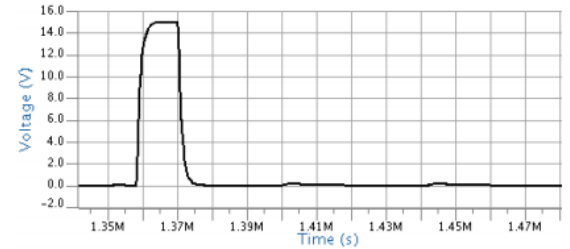
## 4.2: Integrated Scan Driver with Oxide TFTs Using Floating Gate Method



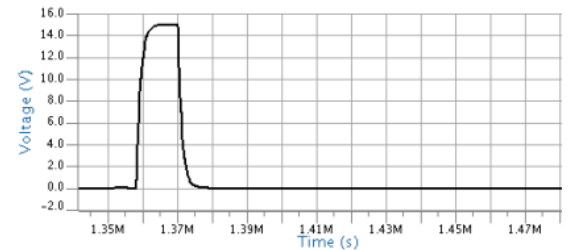
FG에 VL 보다 충분히 낮은 전압을 충전하고, C를 통해 펄스를 공급하면 게이트는 항상 주변 전압보다 충분히 낮은 상태가 되어서 off 상태 실현



(a) VGL1 = VGL2 = VFG = 0V



(b) VGL1 = 0V, VGL2 = -1V, VFG = -2V

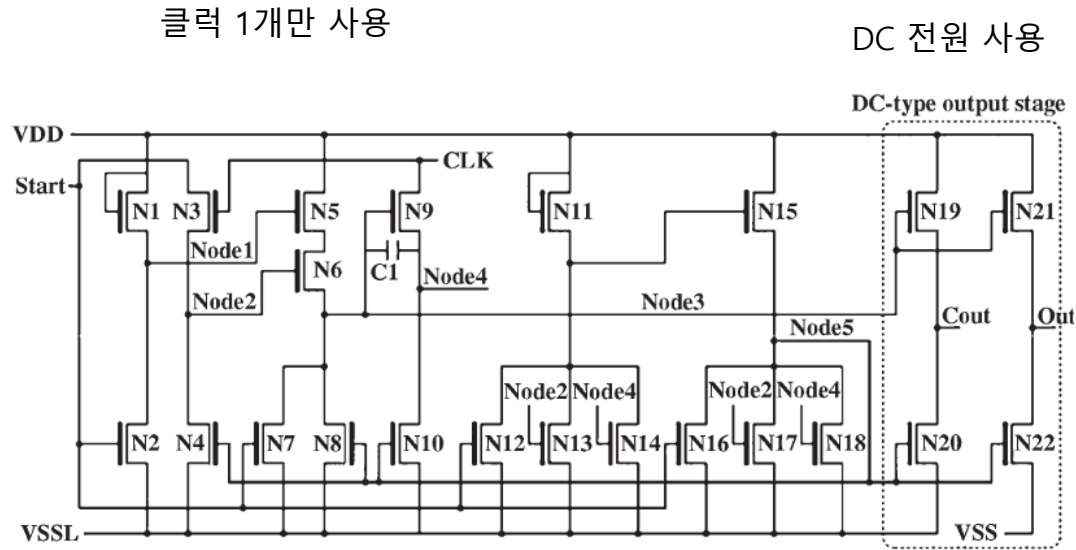


(c) VGL1 = 0V, VGL2 = -2V, VFG = -4V

2012. EDL

Seung-Jin Yoo, Student Member, Sung-Jin Hong, Student Member, Jin-Seong Kang, Student Member, Hai-Jung In, Member, and Oh-Kyong Kwon

## A Low-Power Single-Clock-Driven Scan Driver Using Depletion-Mode a-IGZO TFTs



두개의 직류 Vss 전압 사용 0 V, -5V

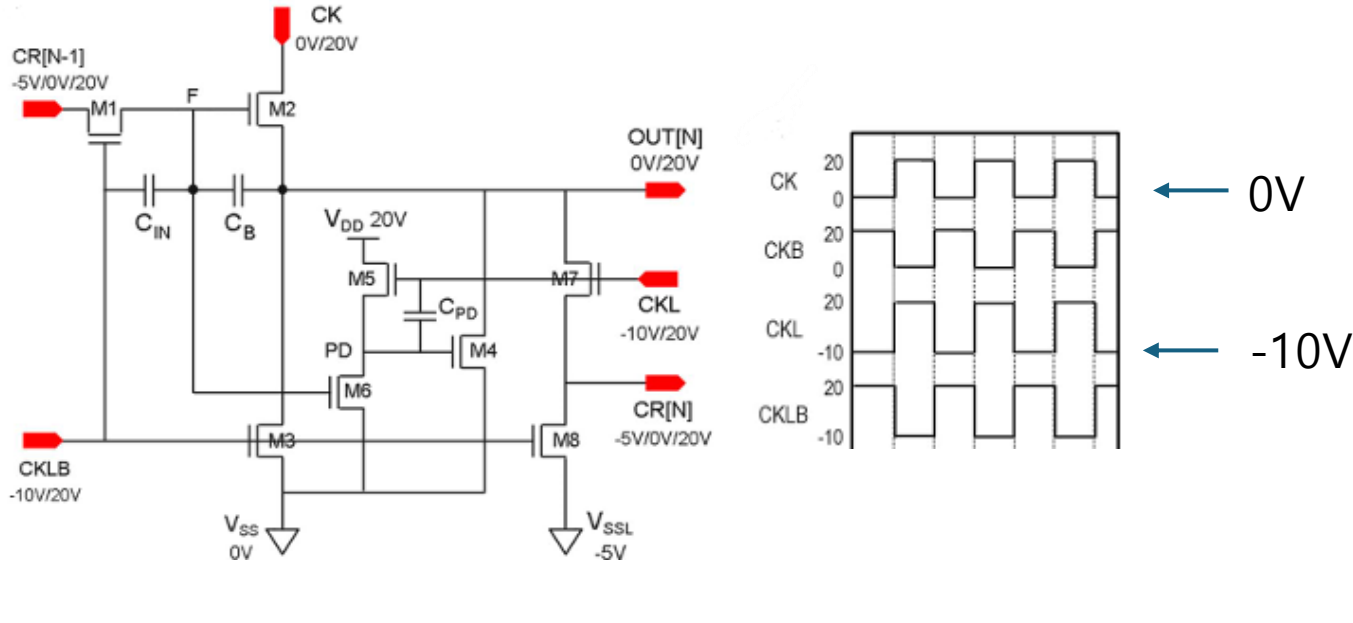
Low 전압이 다른 두 종류의 클럭 사용

문턱 전압이 -로 증가하면서  
leakage에 의한 소비전력 증가.

# 2012. IEEE Electron Device Letters

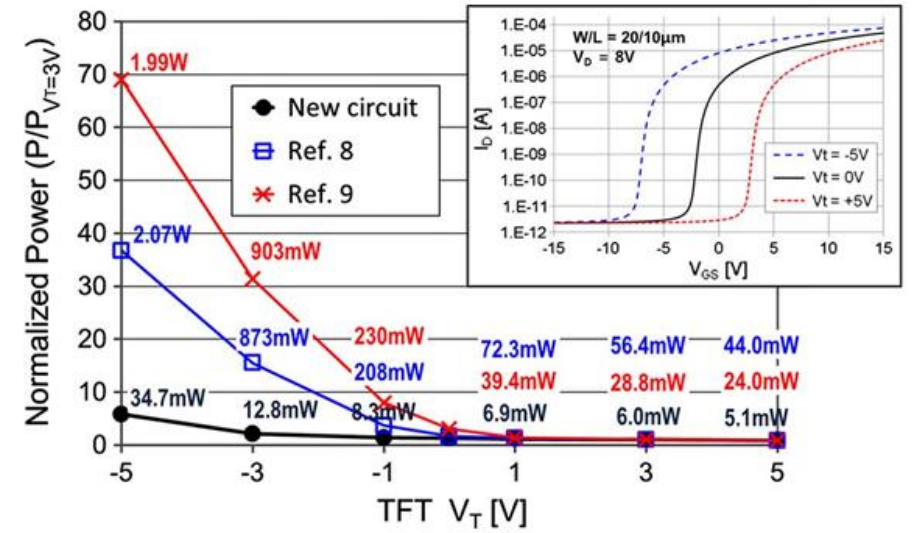
Jae-Eun Pi, MinKi Ryu, Chi-Sun Hwang, ShinHyuk Yang, Sang-Hee Ko Park, Sung-Min Yoon, HongKyun Leem, YounKyung Kim, JoonDong Kim, Hwan Sool Oh, and KeeChan Park

## A Low-Power Scan Driver Circuit for Oxide TFTs



두개의 직류  $V_{SS}$  전압 사용 0 V, -5V

Low 전압이 다른 두 종류의 클럭 사용

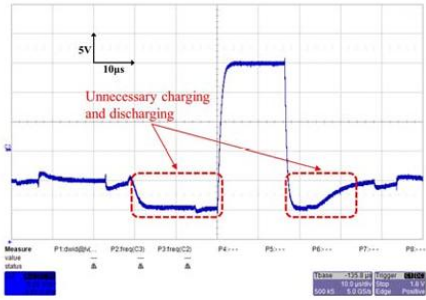


문턱 전압이 -로 증가하면서 leakage에 의한 소비전력 증가.

# 2012. SID

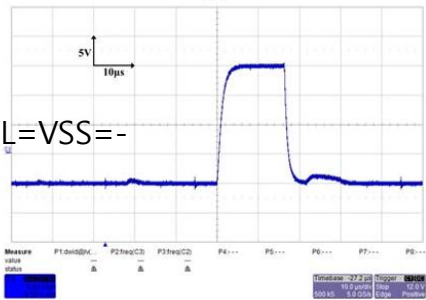
Sung-Jin Hong, Jin-Seong Kang, Chang-Hee Lee and Oh-Kyong Kwon

## Low-Power and Small-Sized Scan Driver Using Amorphous Oxide TFTs

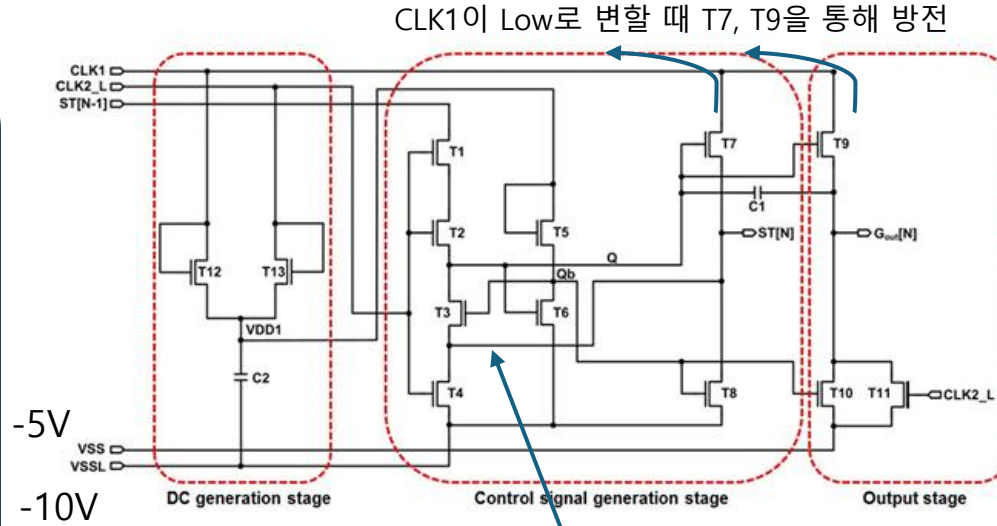


두 그라운드 전원을 사용하면 불필요한 충전방전으로 소비전력 증가

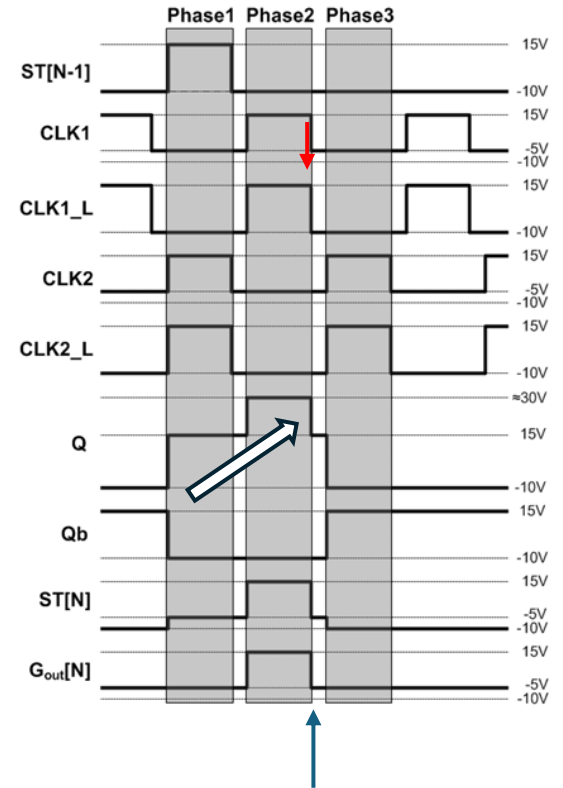
34.7  $\mu$ W/stage, 47 kHz



27.4  $\mu$ W/stage, 47 kHz



ST(N) 출력발생 때 Q가 높은 전압을 유지하도록 T3,T4 사이에 연결하여 T3를 오프로 유지. T4는 완전히 오프가 안 될 듯 (VSSL=CLK2L=-10V)



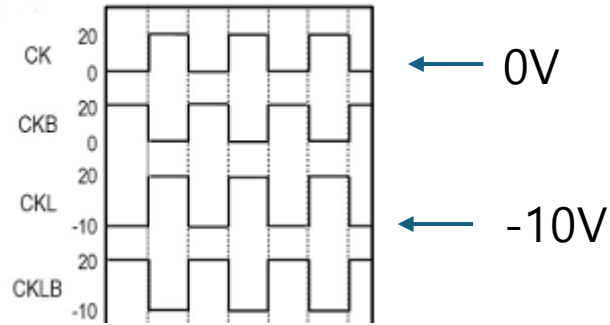
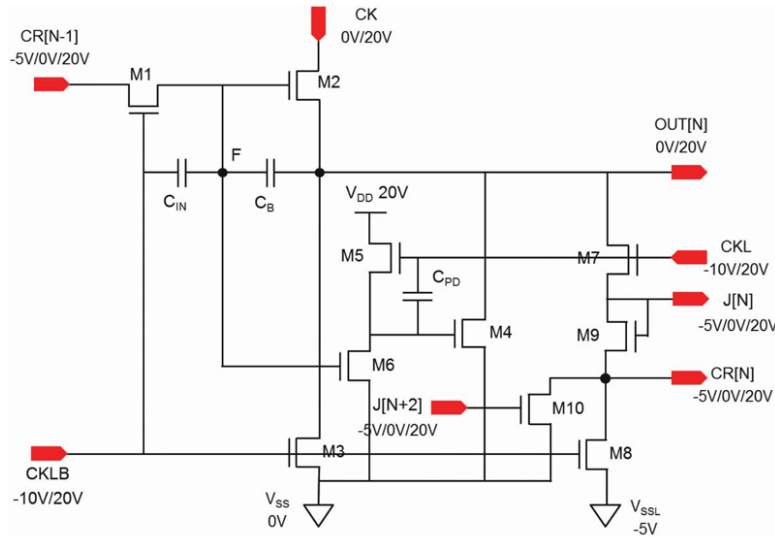
CLK1이 Low로 변할 때 T7, T9을 통해 방전

T7, T9을 Pull up, Pull down 검용으로 사용하여 면적 줄임

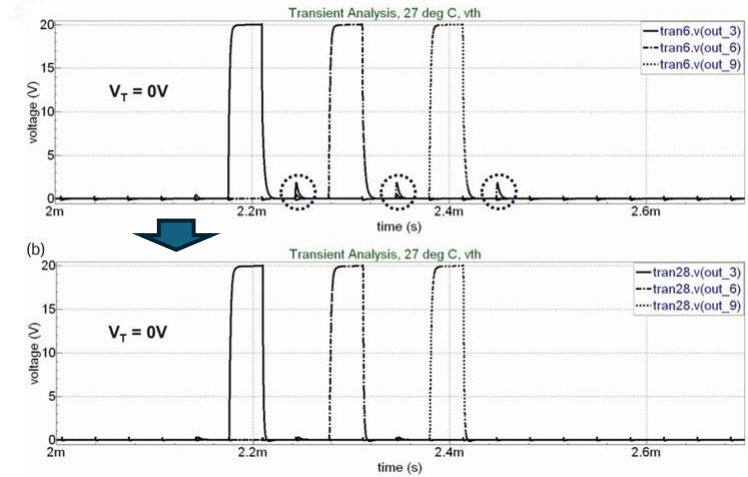
2014. JID

Jae Won Lee<sup>a</sup>, Sang Yeon Kim<sup>a</sup>, Seung O Kim<sup>a</sup>, Hwan Sool Oh<sup>a</sup>, Jae Eun Pi<sup>b</sup>, Chi-Sun Hwang<sup>b</sup> and Kee Chan Park<sup>a</sup> Konkuk University, b:ETRI

### A scan driver circuit for depletion-mode oxide TFTs with stable output waveforms

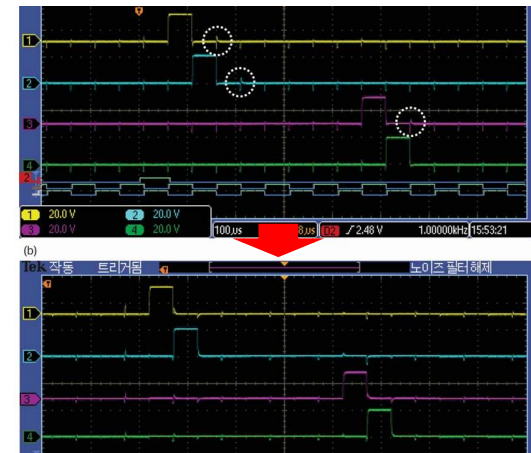


M9, M10 두 개의 TFT 추가 리플 감소



두개의 직류 Vss 전압 사용 0 V, -5V

Low 전압이 다른 두 종류의 클럭 사용



2014. JJAP

Chang-Hee Lee and Oh-Kyong Kwon

# Low-power scan driver embedded with level shifter using depletion-mode amorphous indium-gallium-zinc-oxide thin-film transistors for high-resolution flat-panel displays

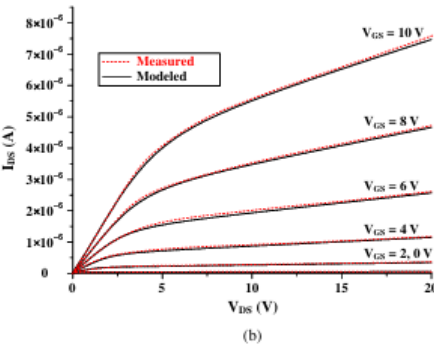
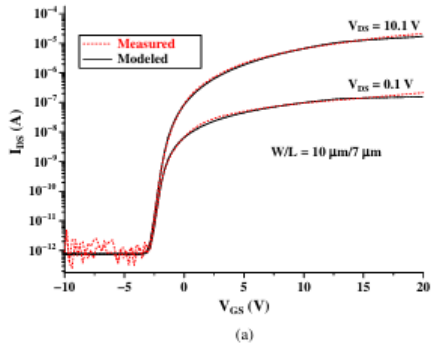
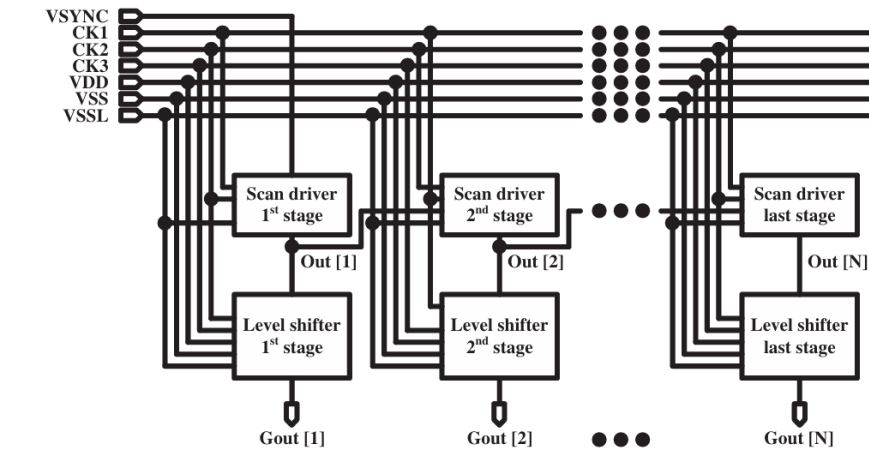
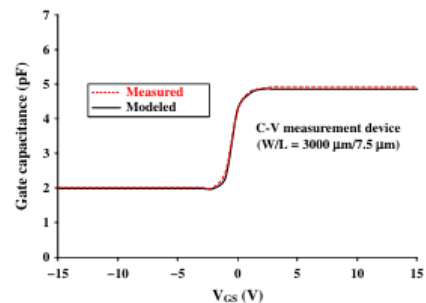
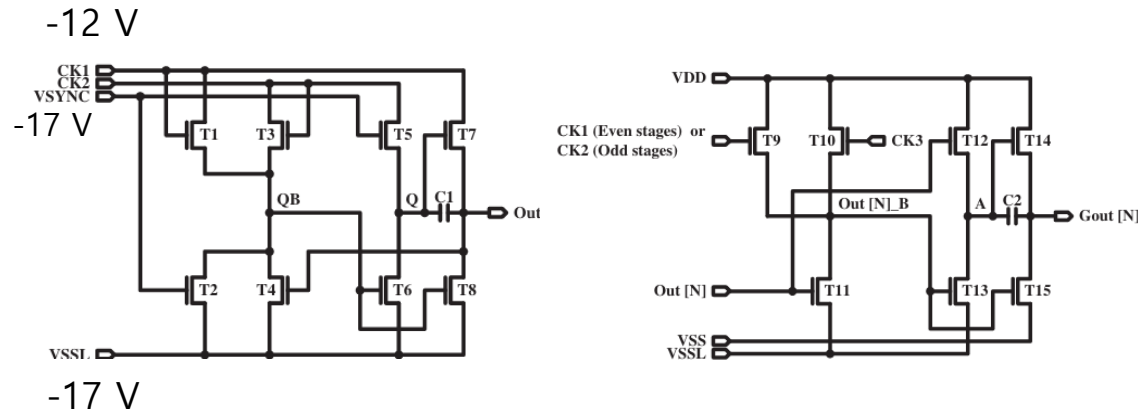


Fig. 1. (Color online) (a) Transfer characteristics and (b) output characteristics of the measured and modeled a-IGZO TFT.



클럭의 전압 스윙폭을 줄임

0.41mW/stage



두개의 직류 Vss 전압 사용 0 V, -5V

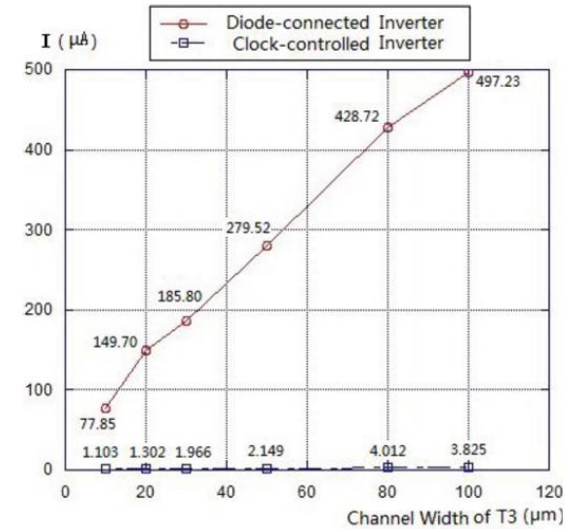
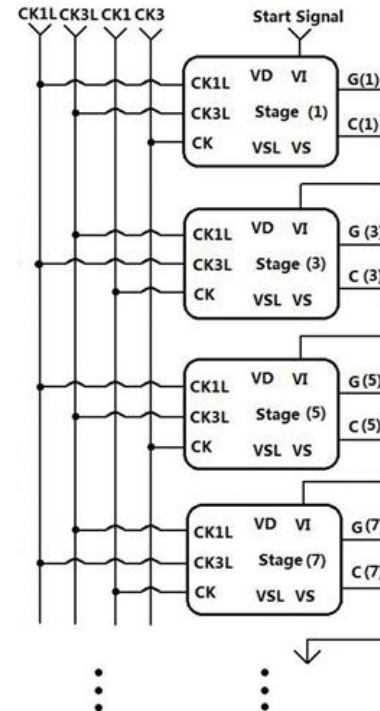
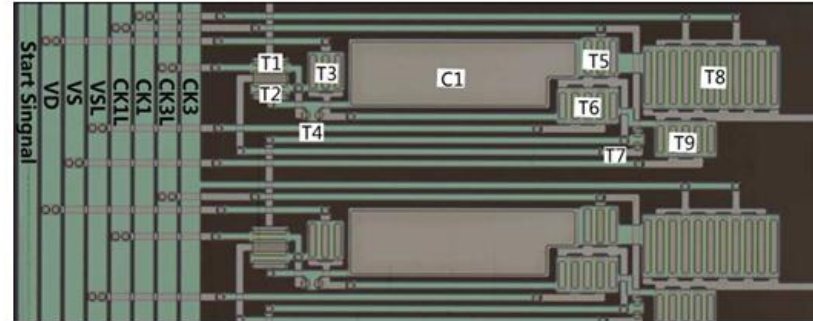
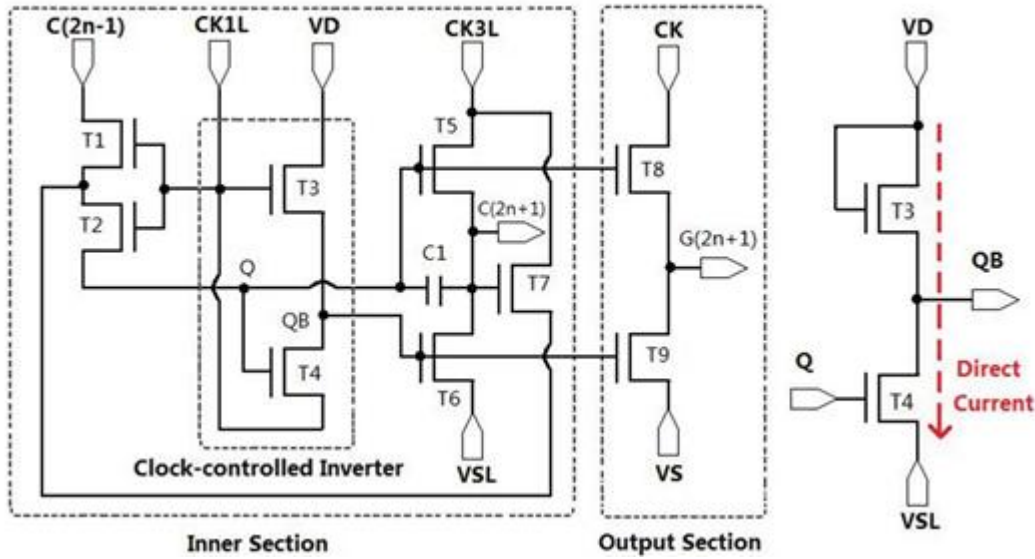
Low 전압이 다른 두 종류의 클럭 사용



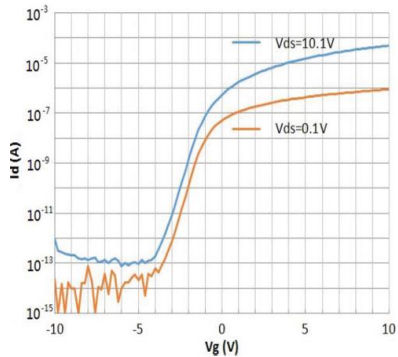
2014. JDT

Wei-Jing Wu, Member, IEEE, Guan-Ming Li, Xing-Heng Xia, Li-Rong Zhang, Lei Zhou, Miao Xu, Lei Wang, and Jun-Biao Peng

**Low-Power Bi-Side Scan Driver Integrated by IZO TFTs Including a Clock-Controlled Inverter**



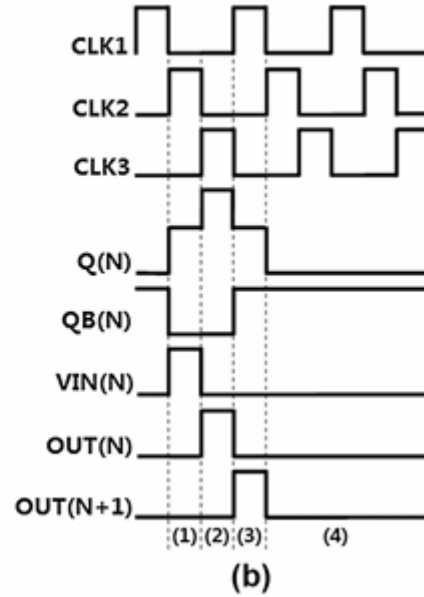
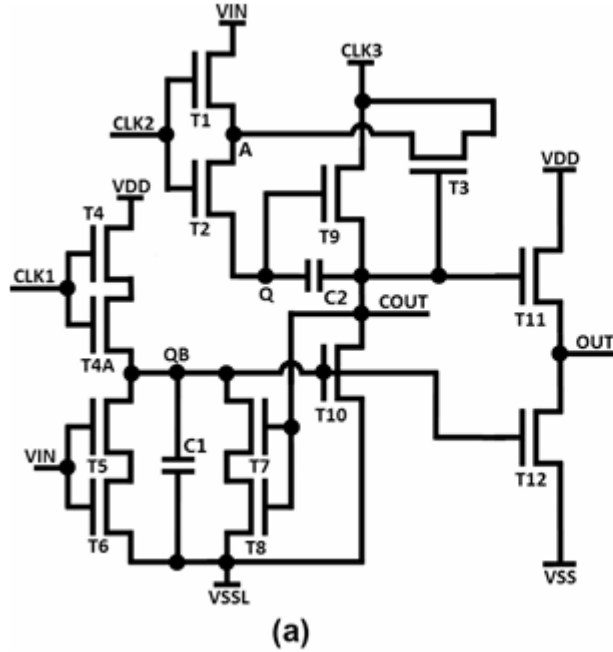
직류 대신 CK1L 사용  
 QB Low일 때 T3 게이트에 Low 전압  
 인가하여 direct current 줄임



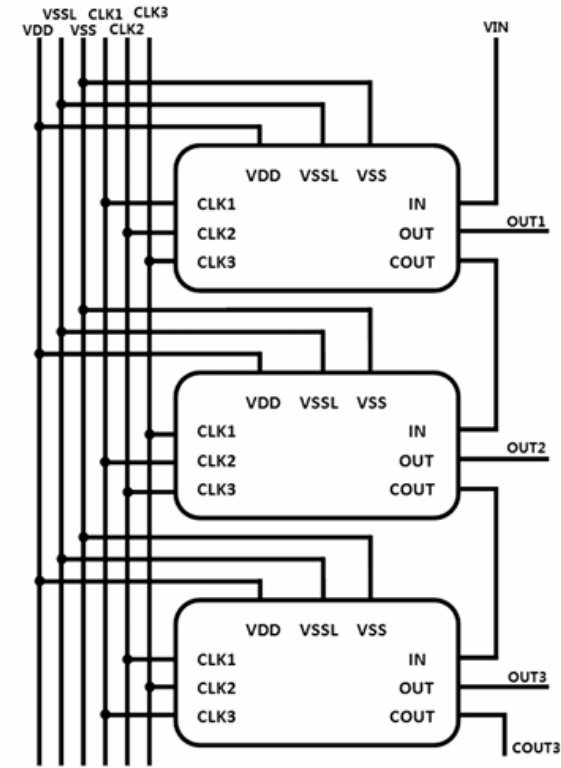
## 2015. Displays

Chang-Yu Huang<sup>a</sup>, Li-Rong Zhang<sup>b</sup>, Lei Zhou<sup>b</sup>, Wei-Jing Wu<sup>c</sup>, Ruo-He Yao<sup>a</sup>, Jun-Biao Peng

### A low-power scan driver employing IZO TFTs including an AC-DC type output module



Vin이 Q에 저장 되고 CLK3가 H가 될 때 T11게이트가 H가 되고 A에도 H가 공급되어 leakage차단, 출력이 H가 될 때 T11게이트도 부트스트랩 됨

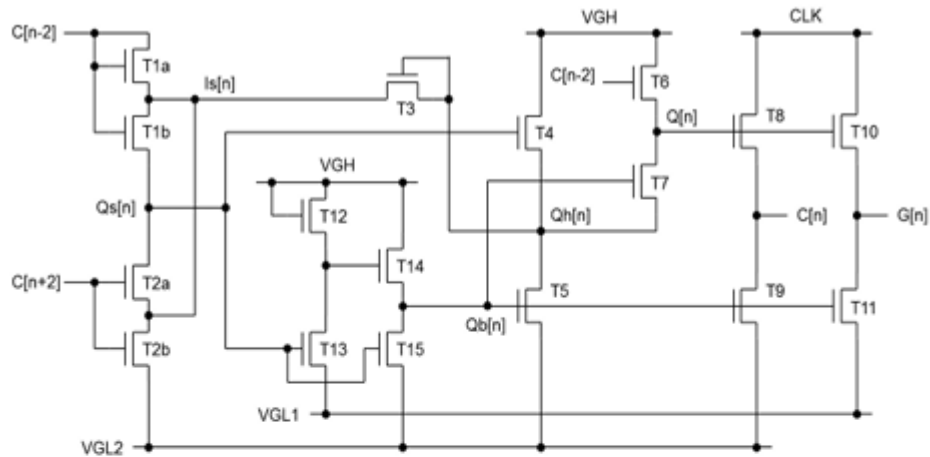


Scan driver	AC-AC	AC-DC
Power consumption ( $\mu\text{W}$ )	393	170

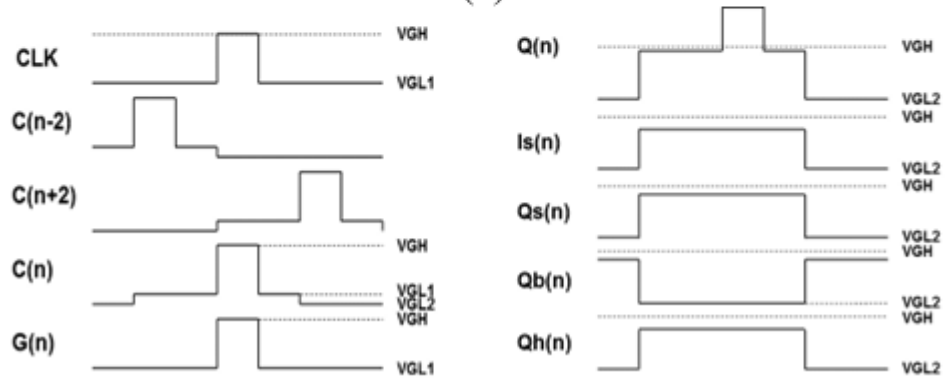
2015. SID

Inhyo Han, Eunji Song, Byeonguk Kang, Kilhwan Oh, Bumsik Kim, Changho Oh, Byungchul Ahn, and Hyongsik Nam, LGDisplay

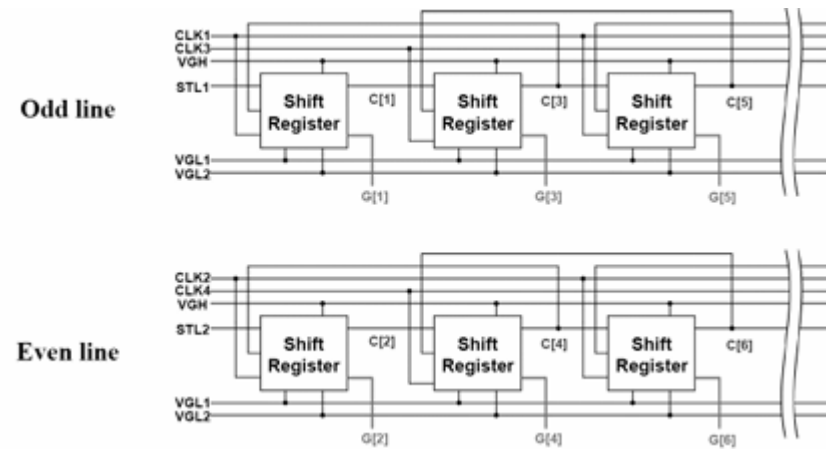
## Depletion-Mode Oxide-TFT Shift Register with Wide Operating Frequency Range for AMOLED Displays



(a)



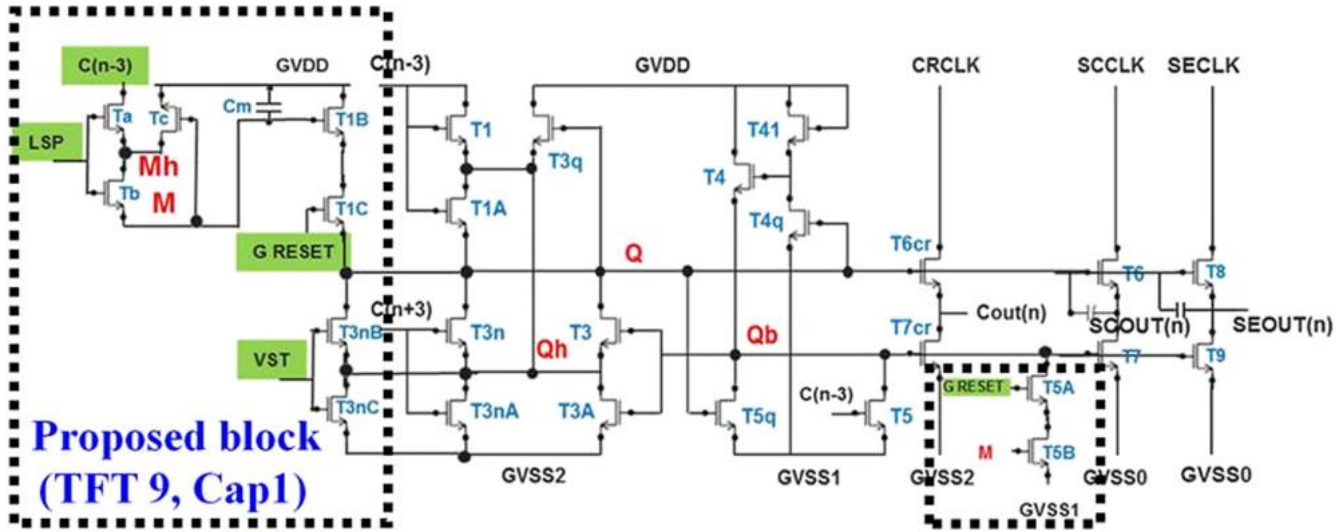
(b)



2019. JSID

In June Kim, Seok Noh, Myung Ho Ban, Kimin Son, Inhyo Han, Hun Ki Shin, Kil hwan Oh, Bumsik Kim, In Byeong Kang, LG display

## Integrated gate driver circuit technology with IGZO TFT for sensing operation

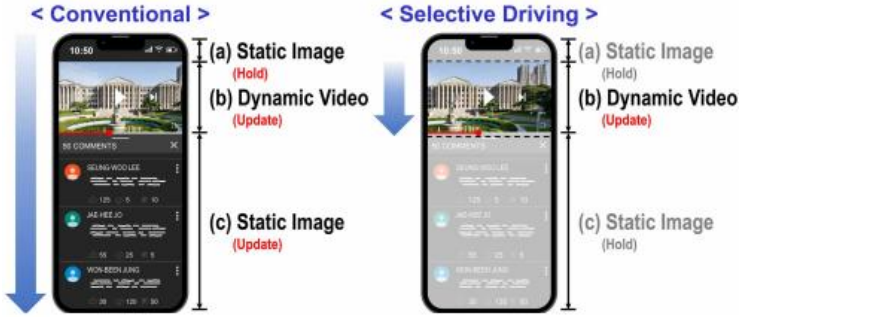
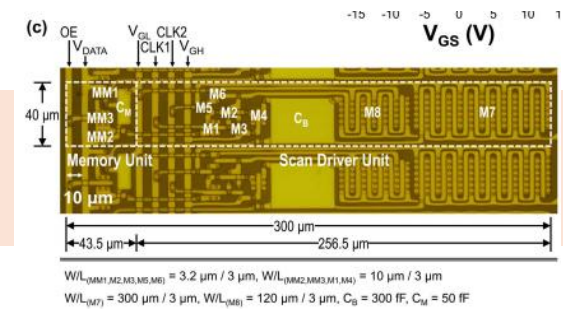


외부 보상을 위해 프레임 사이에 잠깐 화소 드라이버 트랜지스터 특성을 감지 하며 매 프레임마다 일정 부분씩 옮겨가며 감지. 이를 위해 감지부 선택을 하는 회로

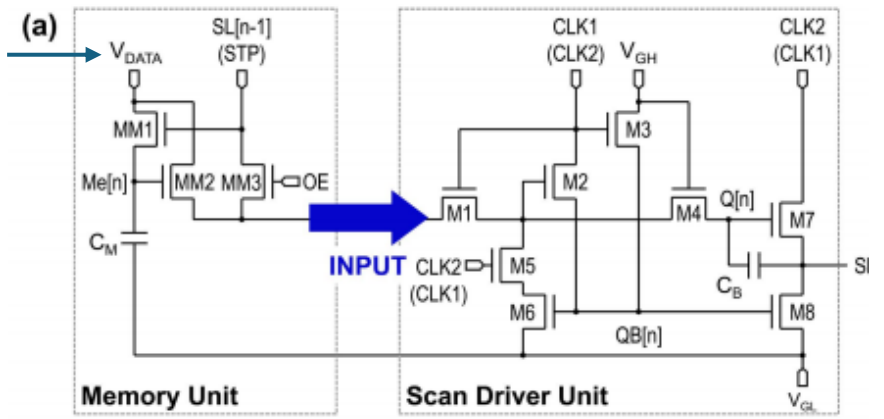
세 종류의 VSS 전원 사용



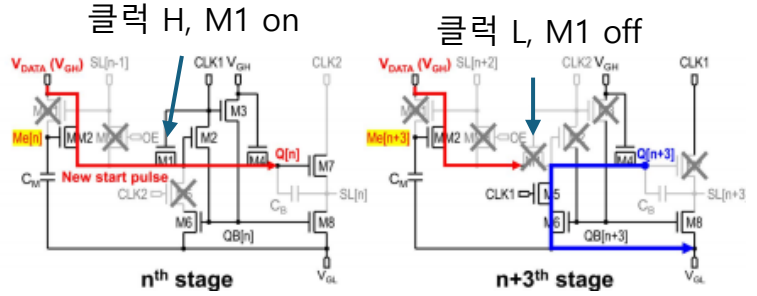
Selective Scan Driver for Low-Power Consumption Using Oxide Thin Film Transistors



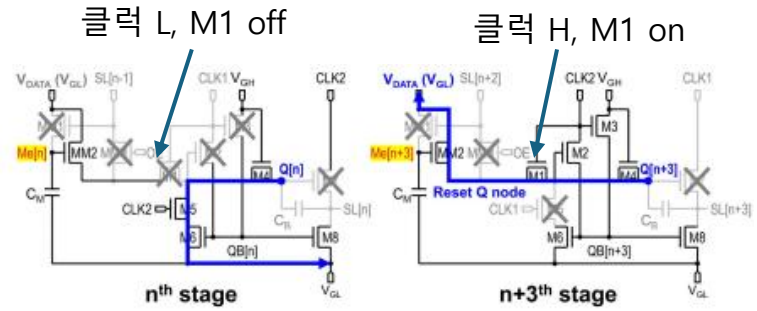
다음 프레임에 시작할 스캔 시간에 Vdata H 입력하여 그 스캔 유닛에만 Me에 저장되도록 함. 스캔을 끝낼 스캔 유닛에도 시간에 맞춰 Vdata를 H로 해서 Me에 충전



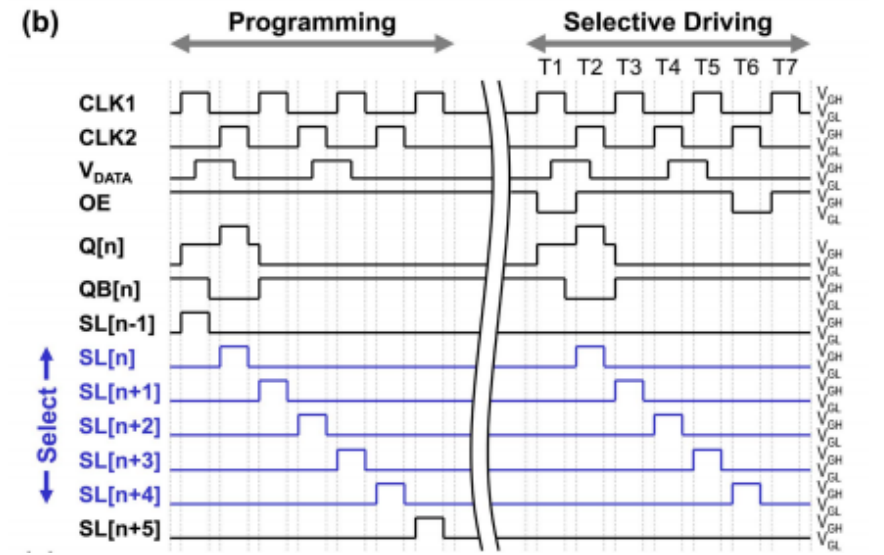
그러면 다음 프레임에서는 STP를 놓지 않고 스캔 시간에 맞춰 MM3를 오프시키고 Vdata H 펄스를 넣으면 MM2가 온 상태인 스캔 라인 Q노드가 H로 충전되어 스캔 시작. 스캔 끝낼 시간에 Vdata를 L로 넣고 MM3 오프하면 MM2가 온이므로 Q노드가 방전되어 스캔이 더 이상 진행되지 않음



스캔 시작할 시간



스캔 끝낼 시간



Vdata H가 될 때 스캔 끝낼 스캔단에서는 Q노드로 전압이 충전되면 안되므로 이 스캔 단의 CLK는 L가 되어서 M1을 오프시켜야 하므로 시작단과 끝단이 클락이 반대인 경우만 가능



**A Simple Scan Driver Circuit Suitable for Depletion-Mode Metal-Oxide Thin-Film Transistors in Active-Matrix Displays**

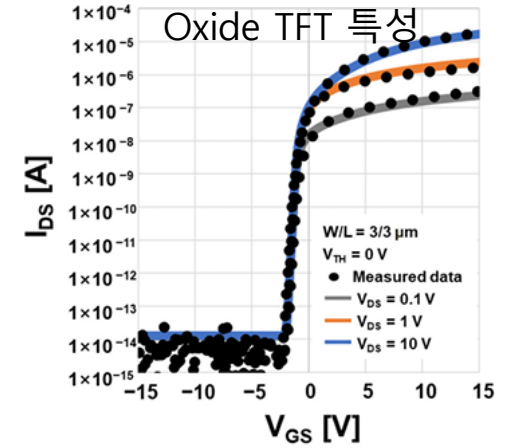
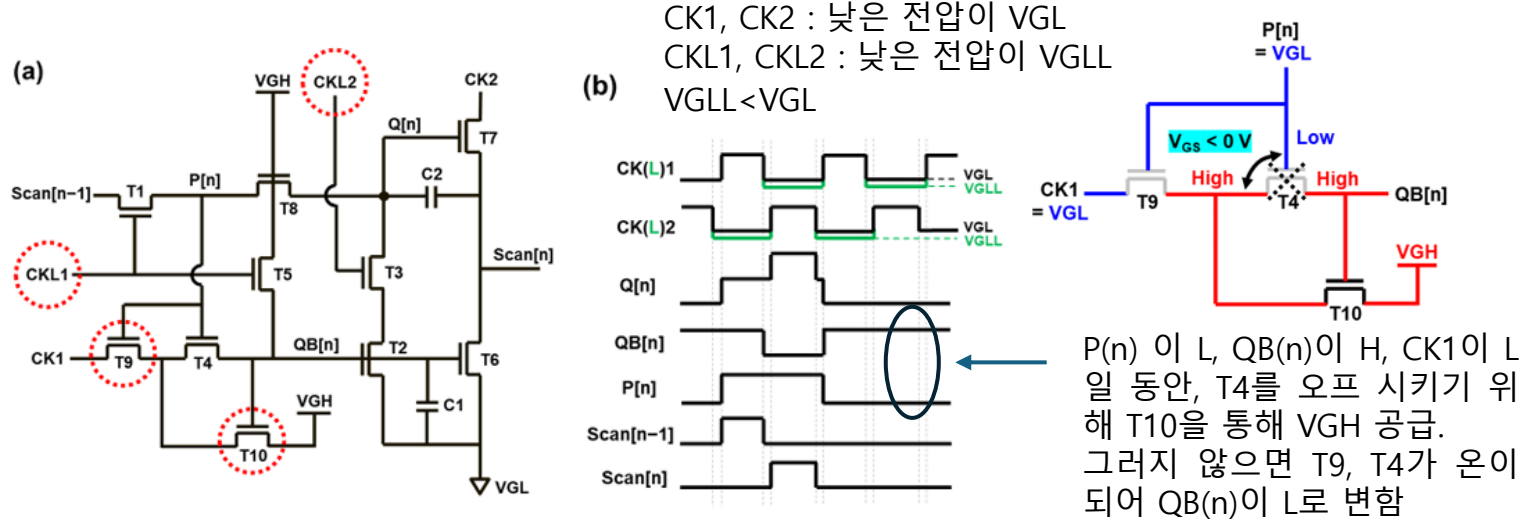


Figure 3. (a) Schematic and (b) timing diagram of the proposed n-type MOx 10T-2C scan driver circuit.

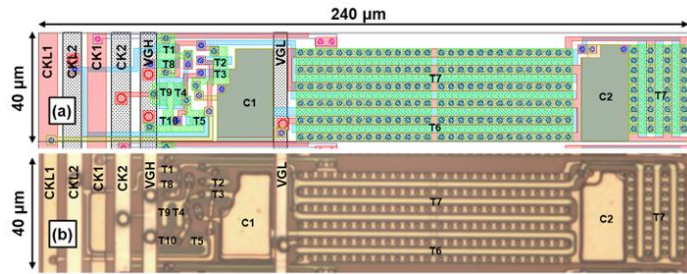
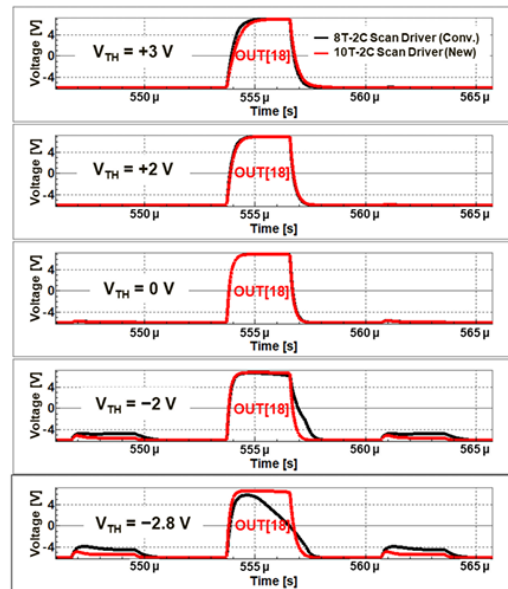


Table 2. Comparison of the proposed 10T-2C scan driver circuit with previous scan driver circuits.

Reference	TFT Type	Structure	Width of Scan Driver Circuit	Negative Limit of TFT V <sub>TH</sub>
[9]	n-type a-IGZO	15T-1C	1200 μm	-2.1 V
[13]	n-type a-IGZO	11T-1C	3500 μm	-0.9 V
[14]	n-type a-IGZO	15T-1C	1000 μm	-0.4 V
This work	n-type a-IGZO	10T-2C	240 μm	-2.8 V



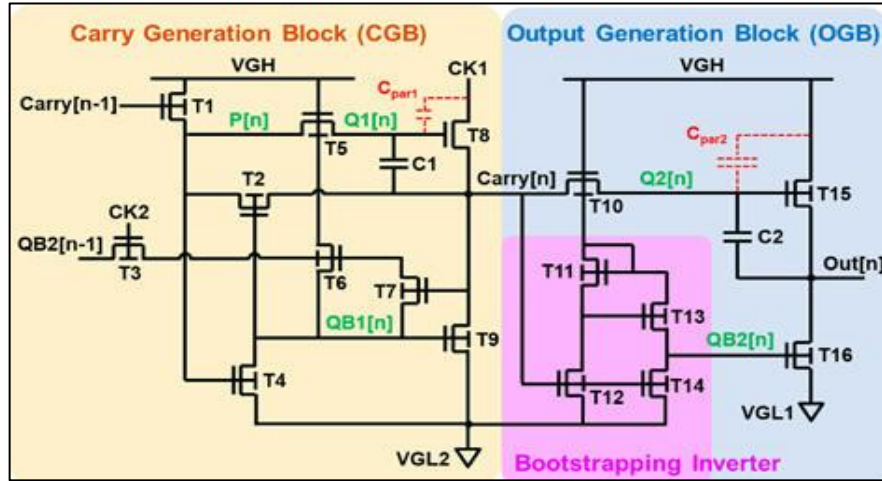
Parameter	Value
VGH	7 V
VGL	-6 V
VGLL	-9 V
CK1, CK2	7 V / -6 V
CKL1, CKL2	7 V / -9 V
W/L of T6	200/3 μm
W/L of T7	400/3 μm
W/L of T1, T8	6/3 μm
W/L of T2, T3, T5	5/3 μm
W/L of T4, T9	8/3 μm
W/L of T10	2/3 μm
C1, C2	190 fF
C <sub>LOAD</sub>	25 pF
R <sub>LOAD</sub>	2 kΩ

V<sub>th</sub> = -2.8 V 까지 잘 동작

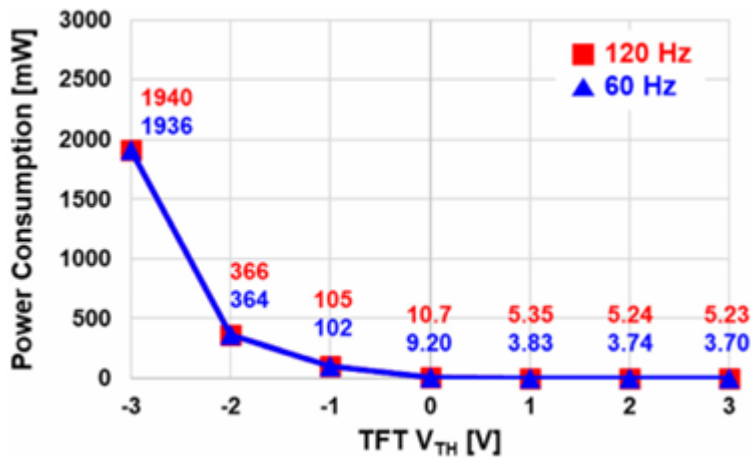
2025. JID,

Hyeong Min Kim, Jung Suk Oh, Yi Kyoung You, Sang Woon Lee and Kee Chan Park, Konkuk University

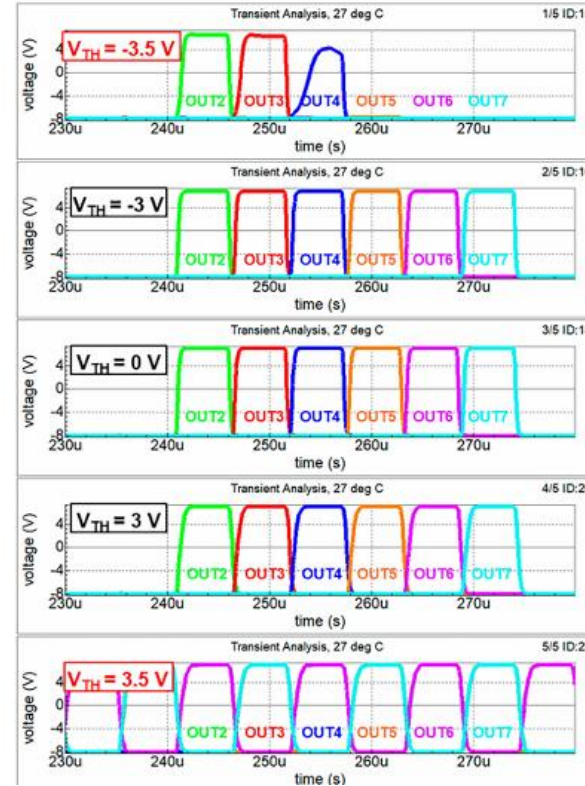
**A low-power metal-oxide scan driver circuit outputting non-overlapping pulses with DC power-supplied buffer**



앞단의 carry 신호가 입력이 될 때 Q2(n)은 Low 를 유지. 이어서 CK1 이 High 가 될 때 T15가 온이 되며 출력 펄스 Out(n) 생성 및 Q2 Bootstrapping.  
 그래서 T15에 클락이 아닌 DC 전원 사용 가능



문턱전압이 작아질 수록 소비전력 증가

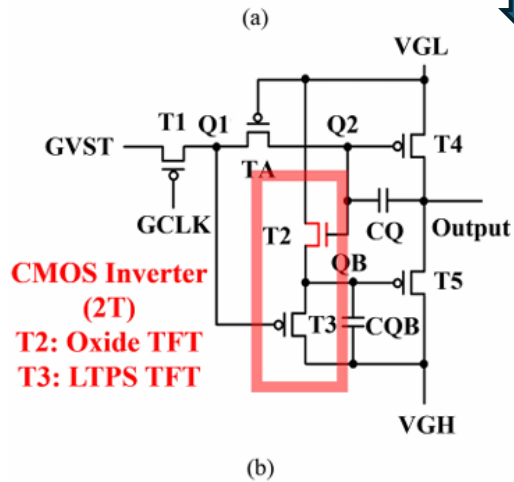
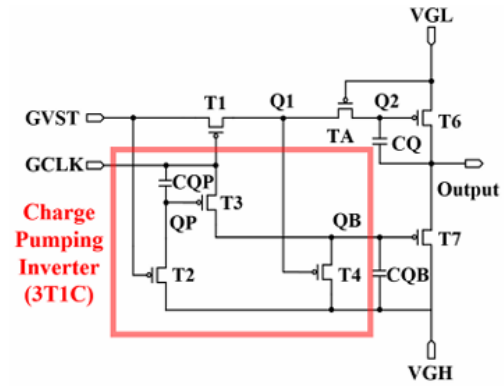


문턱 전압별 출력 펄스

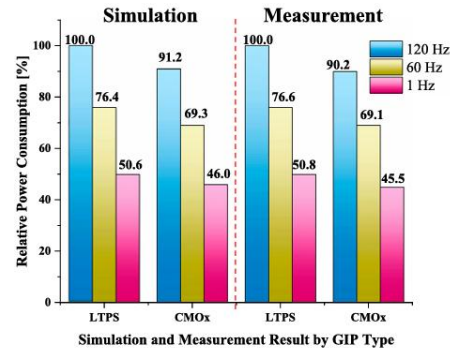
2025. JID,

Se Hwan N<sup>a,b</sup>, Seok Gyu Hong<sup>a</sup>, Yong Seon Hwang<sup>a</sup>, Jung Chul Kim<sup>a,b</sup>, Juhn Suk Yoo<sup>b</sup> and HyunJaeKim<sup>a</sup>

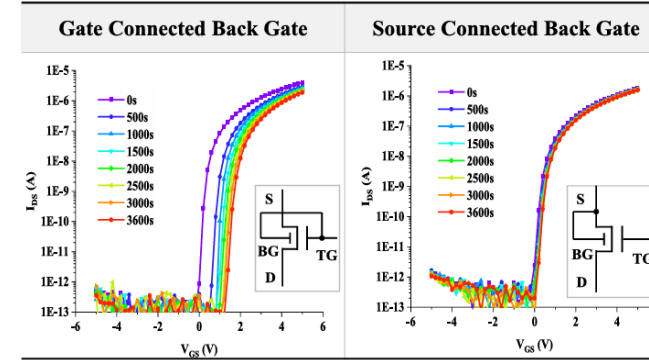
## Gate driver-in-panel circuit using low-temperature polycrystalline silicon and oxide TFTs with mitigated positive bias temperature stress



Oxide TFT와 P 채널 LTPS 채널 TFT로 CMOS inverter 채택



제안 회로에서 소비전력 감소



백게이트 연결 위치에 따른 PBTS 비교



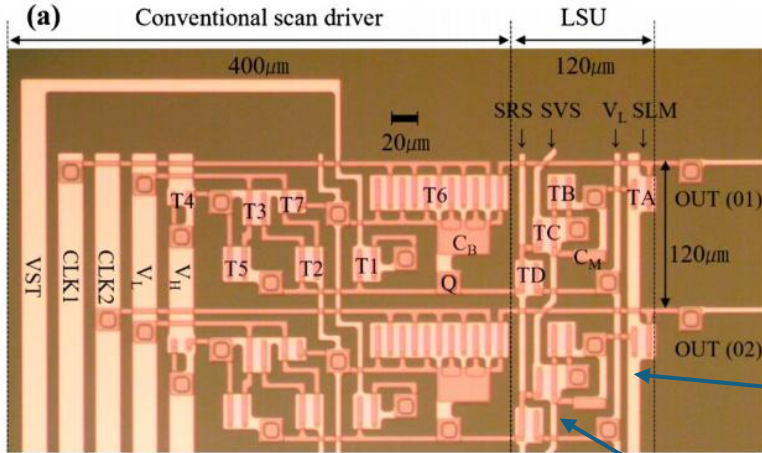
Parameters	Specifications
Screen Diagonal	6.1"
Resolution	FHD
Pixel Density	456 ppi
TFT Process	LTPO
Frame Rate	1~120 Hz
<b>Gate Driver (GIP)</b>	<b>CMOx (6T2C)</b>
Pixel Circuit	LTPO (7T1C)
Power Save (Compared to conventional GIP)	9.8%p (@ 120 Hz) 5.3%p (@ 1 Hz)
V <sub>TH</sub> Margin	< ±15V

Figure 10. Specifications of the test vehicle for the CMOx GIP and the image of AMOLED display panel based on LTPO.

2025. JID,

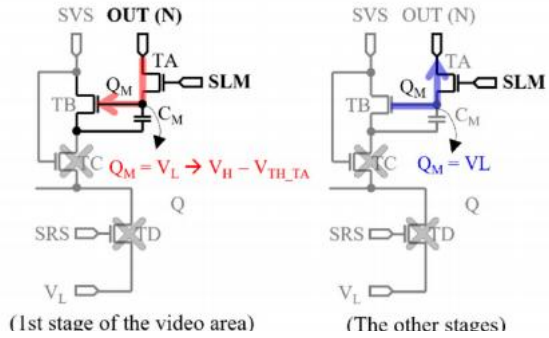
Minjae Jeong, Young Wook Kim, Ki Taeg Shin, Hoon Jeong, Jeong Ki Park & Hyun Jae Kim

## Modular line-selector unit for enabling selective scan driving in conventional oxide TFT scan drivers



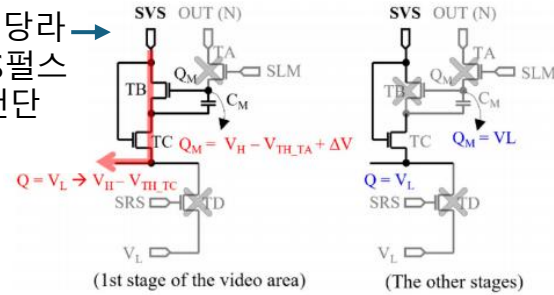
$V_H = 15\text{ V}$ ,  $V_L = -15\text{ V}$ , CLK, VST, RST, SLM, SVS, SRS = -15 V to 15 V  
 W/L (T4) = 5.0  $\mu\text{m}$  / 8.0  $\mu\text{m}$ , W/L (T7) = 10.0  $\mu\text{m}$  / 8.0  $\mu\text{m}$   
 W/L (T6) = 200.0  $\mu\text{m}$  / 6.0  $\mu\text{m}$ , W/L (Others) = 20.0  $\mu\text{m}$  / 8.0  $\mu\text{m}$   
 $C_B = 150\text{ fF}$ ,  $C_M = 40\text{ fF}$ , RC of the scan line is 1.0 k $\Omega$  and 20 pF.

(a) Period 'P1'



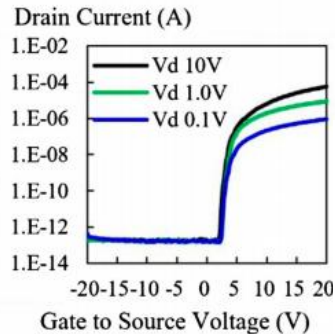
다음 프레임에서 비디오가 시작될 스캔 타임에 SLM 펄스 입력. 이 라인 분 회로에는 QM 이 충전되고 그 외 라인 분 회로에는 QM 이 L로 방전

(b) Period 'P2'



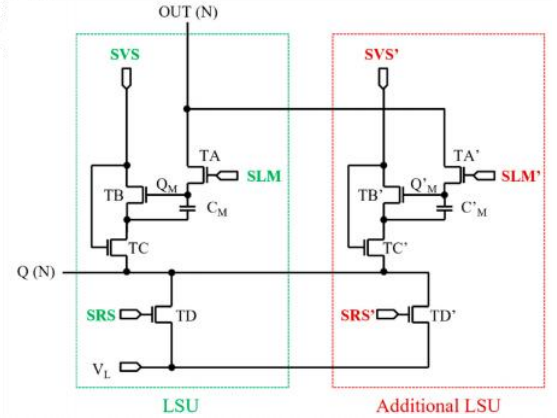
다음 프레임에서 해당라인 스캔 직전에 SVS 펄스 입력. 해당 라인스캔단에만 Q신호 입력

(c)

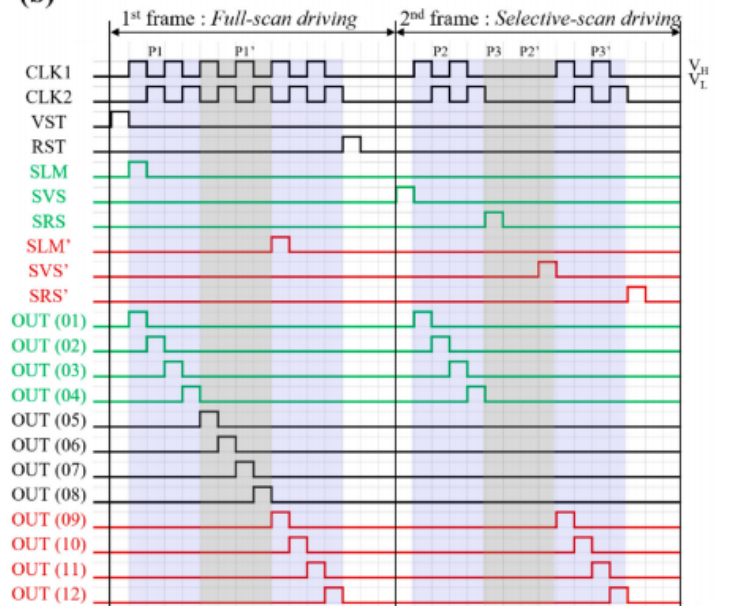


동영상부 끝나는 시간에 맞춰 SRS신호 입력 Q를 L로 낮춰 더 이상 출력이 진행되지 않도록 함

비디오 부가 변경이 될 때는 SVS, SLM, SRS 모두 펄스 넣어 QM을 모두 L로 만듦

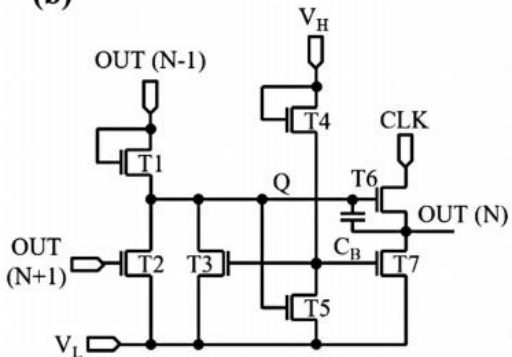


(b)



가운데가 text 아래 위 두 군데로 비디오가 있을 때 double LSU 및 신호, SVS, SVS'으로 선택

(b)



Conventional circuit

2025. JID,

Eun Kyo Jung<sup>a</sup>, Hwarim Im<sup>b</sup> and Yong-Sang Kim<sup>a</sup>

**Emission driver circuit based on metal-oxide thin-film transistors capable of leakage current suppression for output stability**

2018. IEEE ED

Jong-Seok Kim, Student Member, Jung-Woo Byun, Student Member, Jun-Hwan Jang, Student Member, Yong-Duck Kim, Student Member, Ki-Lim Han, Jin-Seong Park, and Byong-Deok Choi

## A High-Reliability Carry-Free Gate Driver for Flexible Displays Using a-IGZO TFTs

디코더  
적용

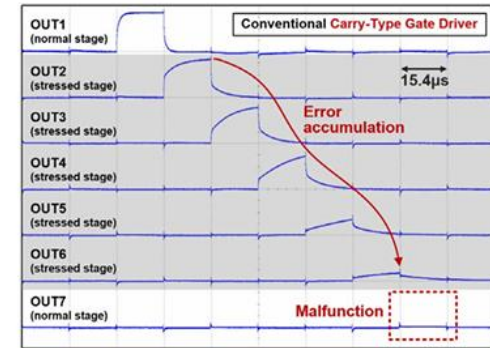
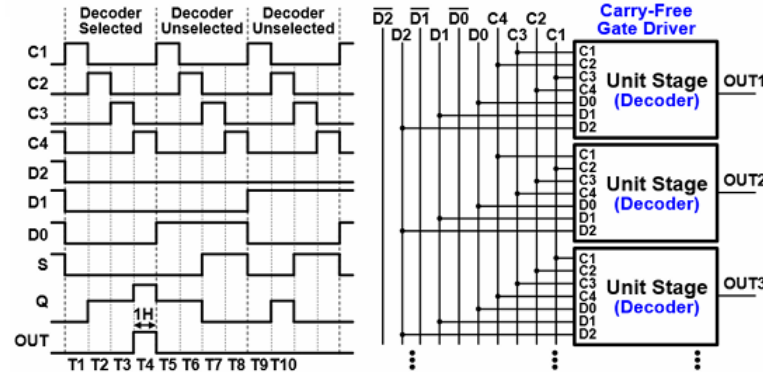
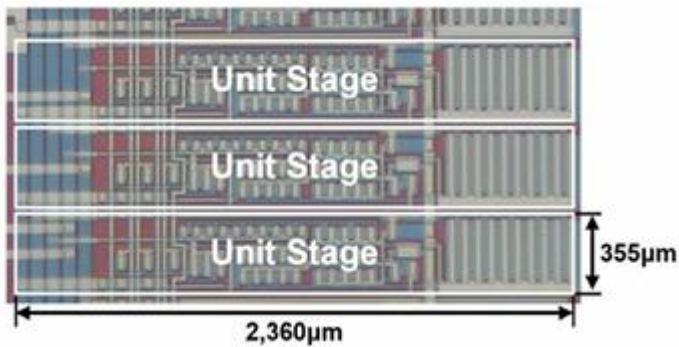
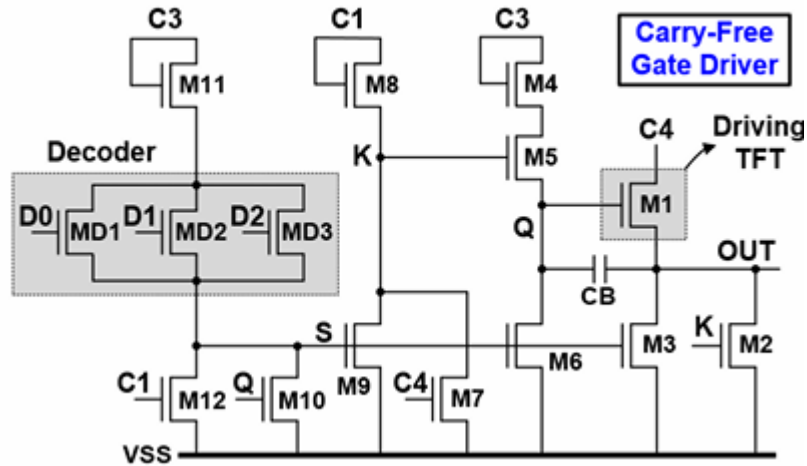


Fig. 13. Measured error accumulation phenomenon of carry-type gate driver.

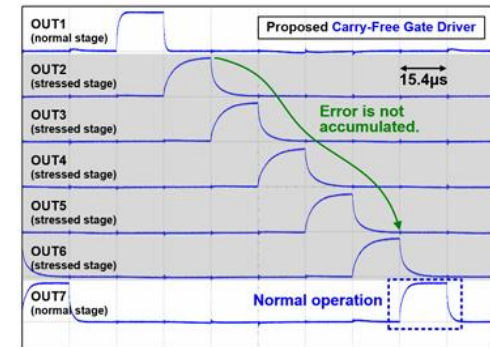


Fig. 14. Measured waveforms of the proposed carry-free gate driver.