Highly Sensitive Fingerprint Readout IC for Glass-Covered Mutual Capacitive Fingerprint Sensor

Kyeongmin Park, Joohyeb Song and Franklin Bien

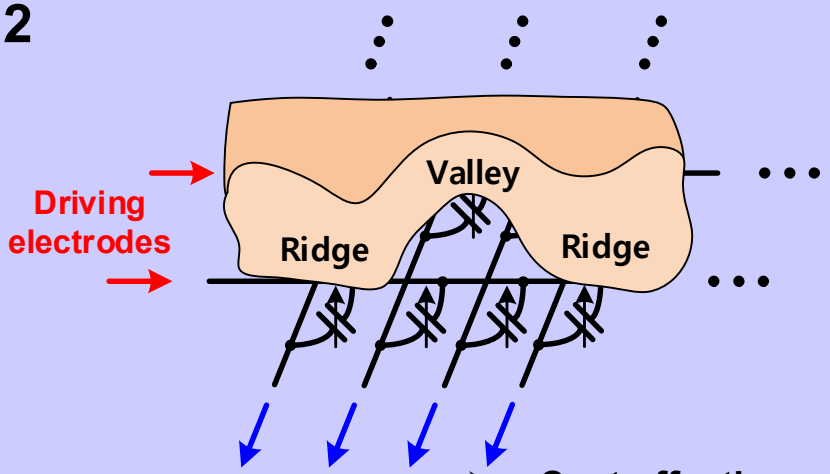
Ulsan National Institute of Science and Technology (UNIST), Korea

Motivation & Technical Issues

1

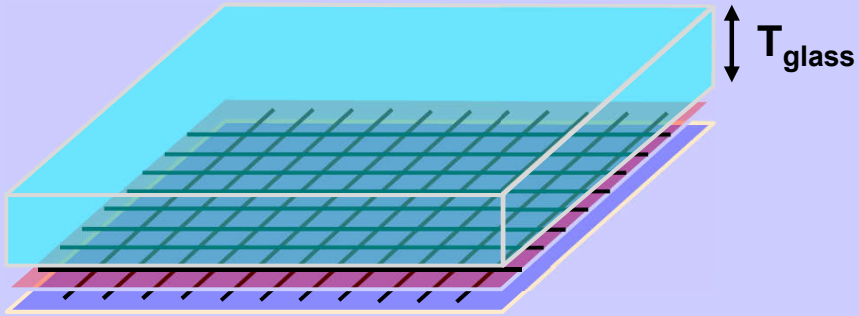
- Home button-less phone
- Edge-to-edge display
- Glass-covered fingerprint sensor

2



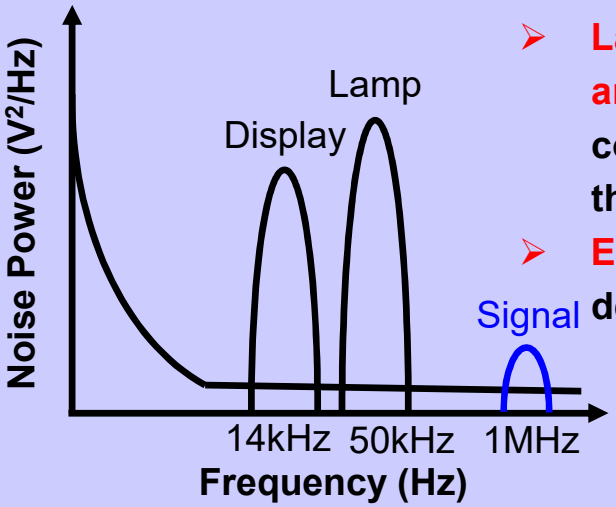
- Cost-effective
- Simple manufacturing process

3



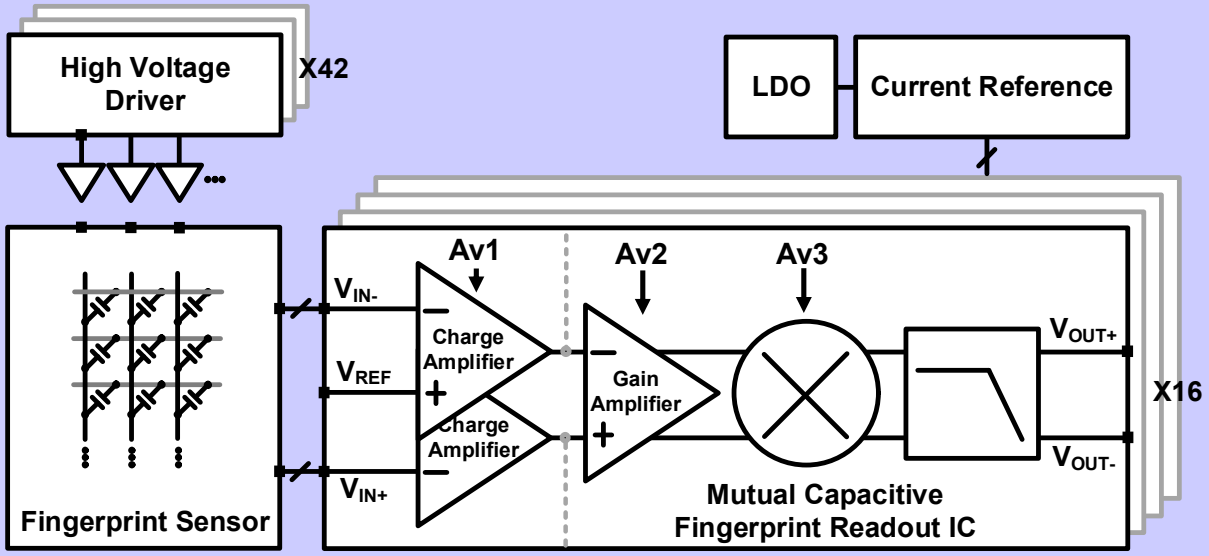
- The cover glass protects the device from external forces
- T_{glass}: the thickness of glass
- Sensitivity $\propto 1/T_{glass}$

4



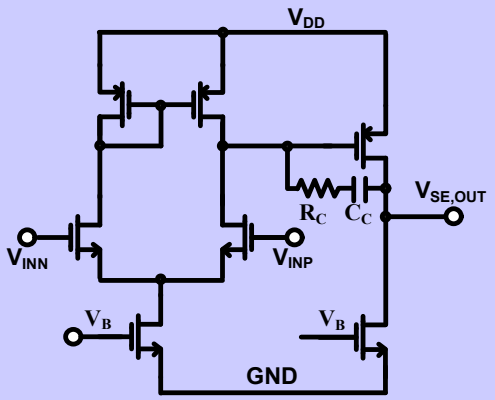
- Very small signal levels
- Large display noise and lamp noise are coupled through the sensor
- Electronic noise deteriorates SNR

Overall Architecture of Fingerprint Authentication System

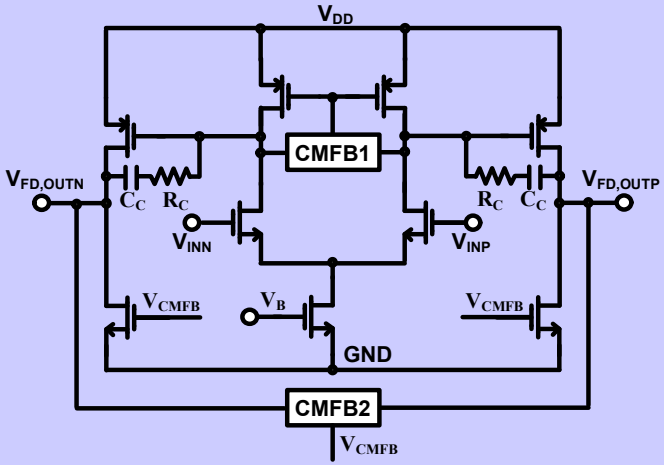


- For high sensitivity, HV driver applies 20V excitation signal through the fingerprint sensor
- DC offset and flicker noise is reduced by using modulation and demodulation process
- Differential sensing scheme is used for common mode rejection (CMR)
- $A_{Total} = A_{V1} + A_{V2} + A_{V3} = -37dB$,
  Where $A_{V1} = -86dB$ (@0.1T glass), $A_{V2} = 31dB$ and $A_{V3} = 18dB$
- Gain amplifier and mixer have band-pass operation at 1MHz, which filter out the out of band noise

Circuit Implementation



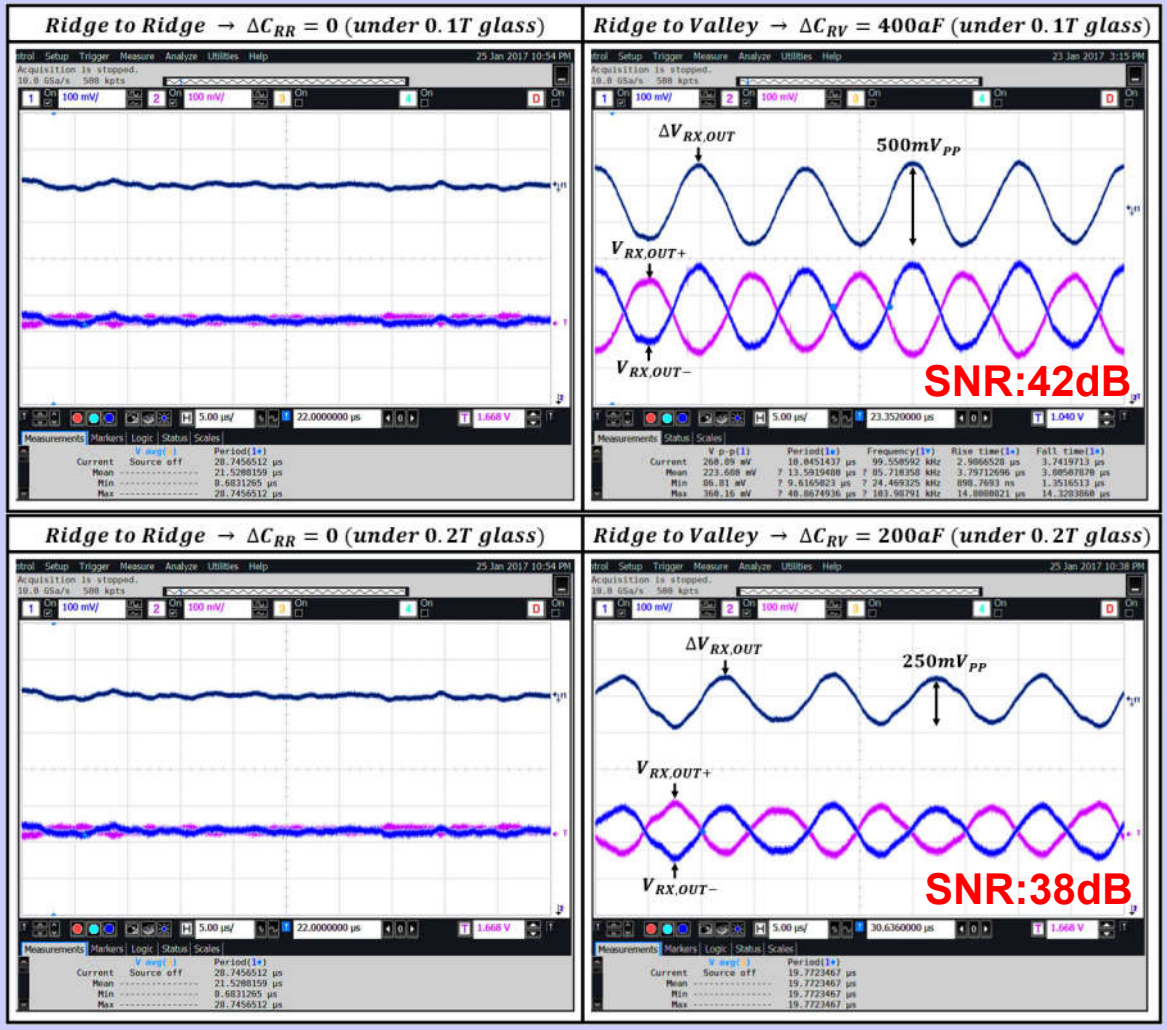
Single-ended two stage miller OTA



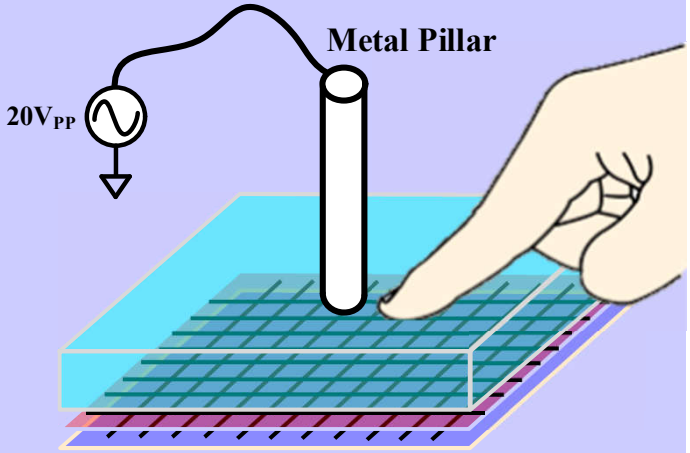
Fully-differential two stage miller OTA

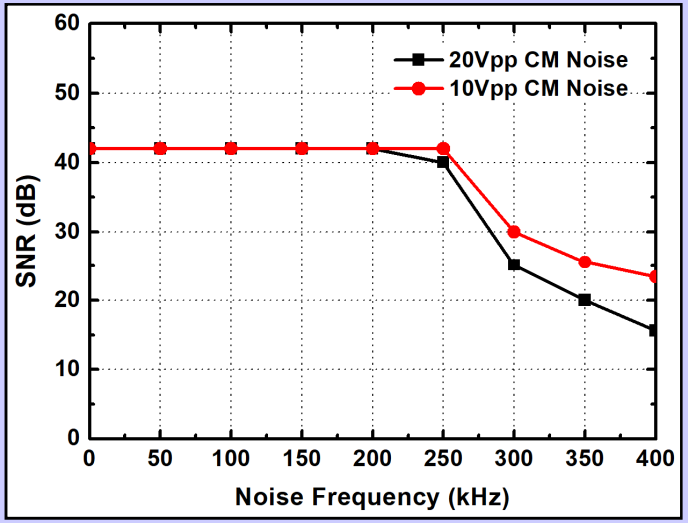
Measurement Results

w/ CM Noise



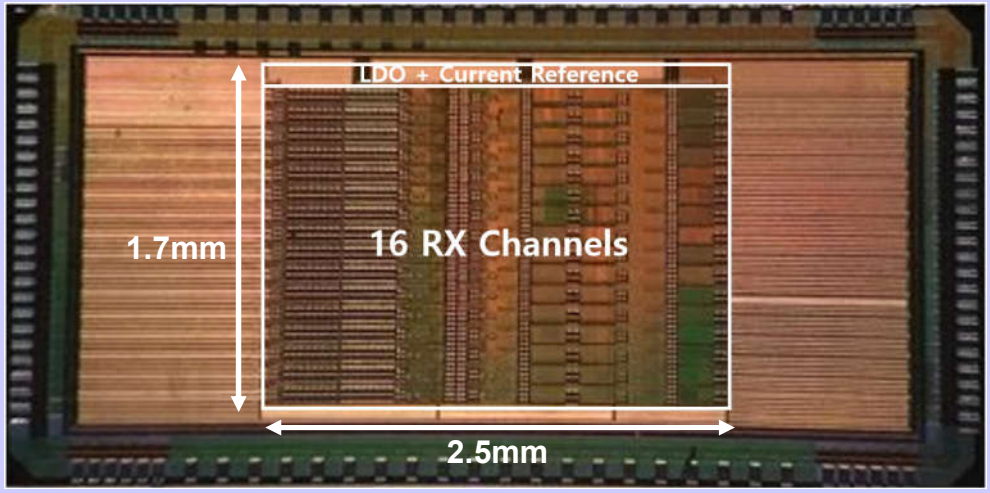
w/o CM Noise (@0.1T glass)





Performance summary & Conclusion

Process		0.18μm CMOS process
Channel		TX: 42
		RX: 32
SNR (dB)	0.1T glass	42 dB
	0.2T glass	38 dB
Noise Immunity	10 V_{PP}	0 ~ 300kHz
	20 V_{PP}	0 ~ 270kHz
Die Area (mm^2)		4.3
Supply		3.3V
Power		28mW (RX)



- A 42dB SNR is achieved, while variation of mutual capacitor is 400aF
- A 38dB SNR is achieved, while variation of mutual capacitor is 200aF
- Display noise and lamp noise can be rejected by noise rejection techniques