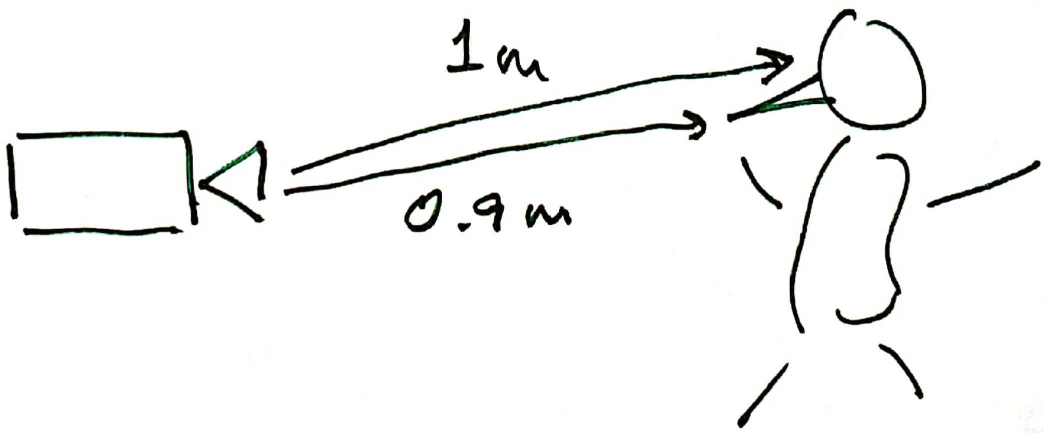
EECS 16A, Module 2

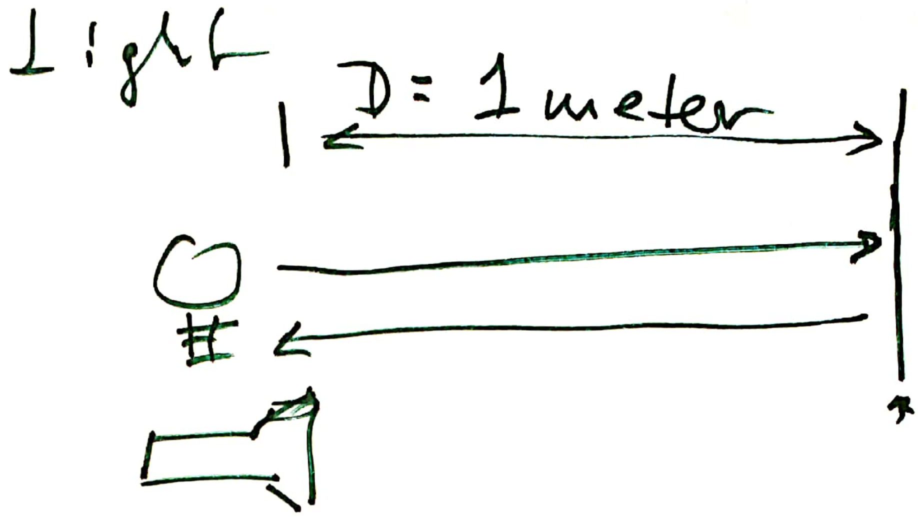
Design

- Range Finder Camera (Lidar)
- More circuits

Range Finder Camera

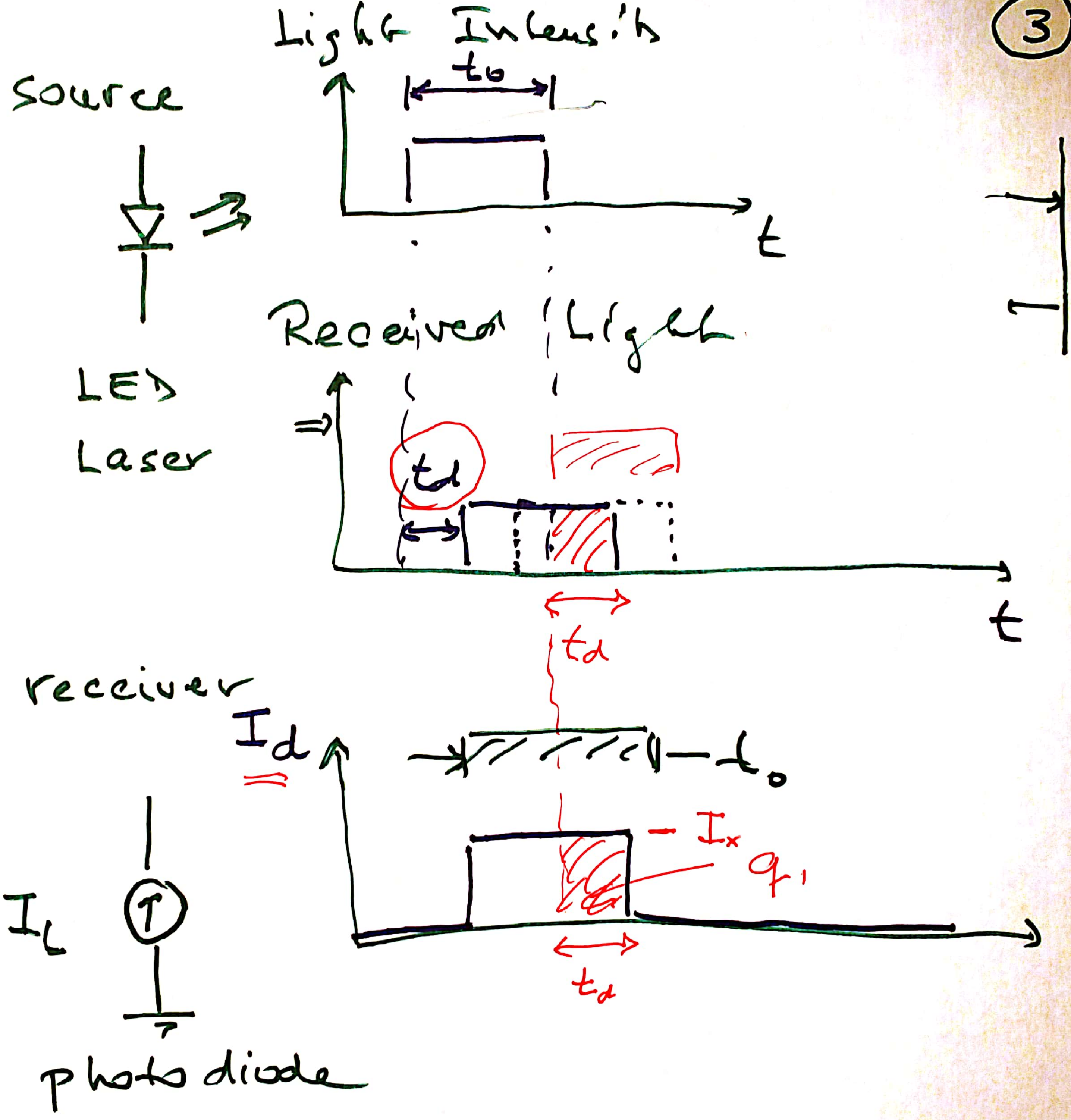
LIDAR





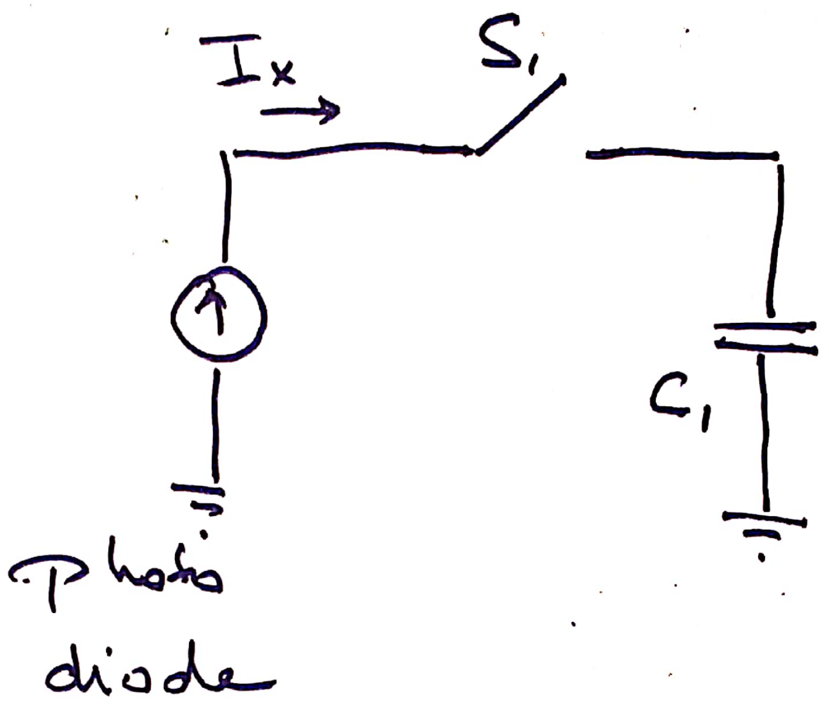
$$t_d = \frac{2D}{c} = \frac{2 \cdot 1m}{300 \cdot 10^6 \frac{m}{s}}$$

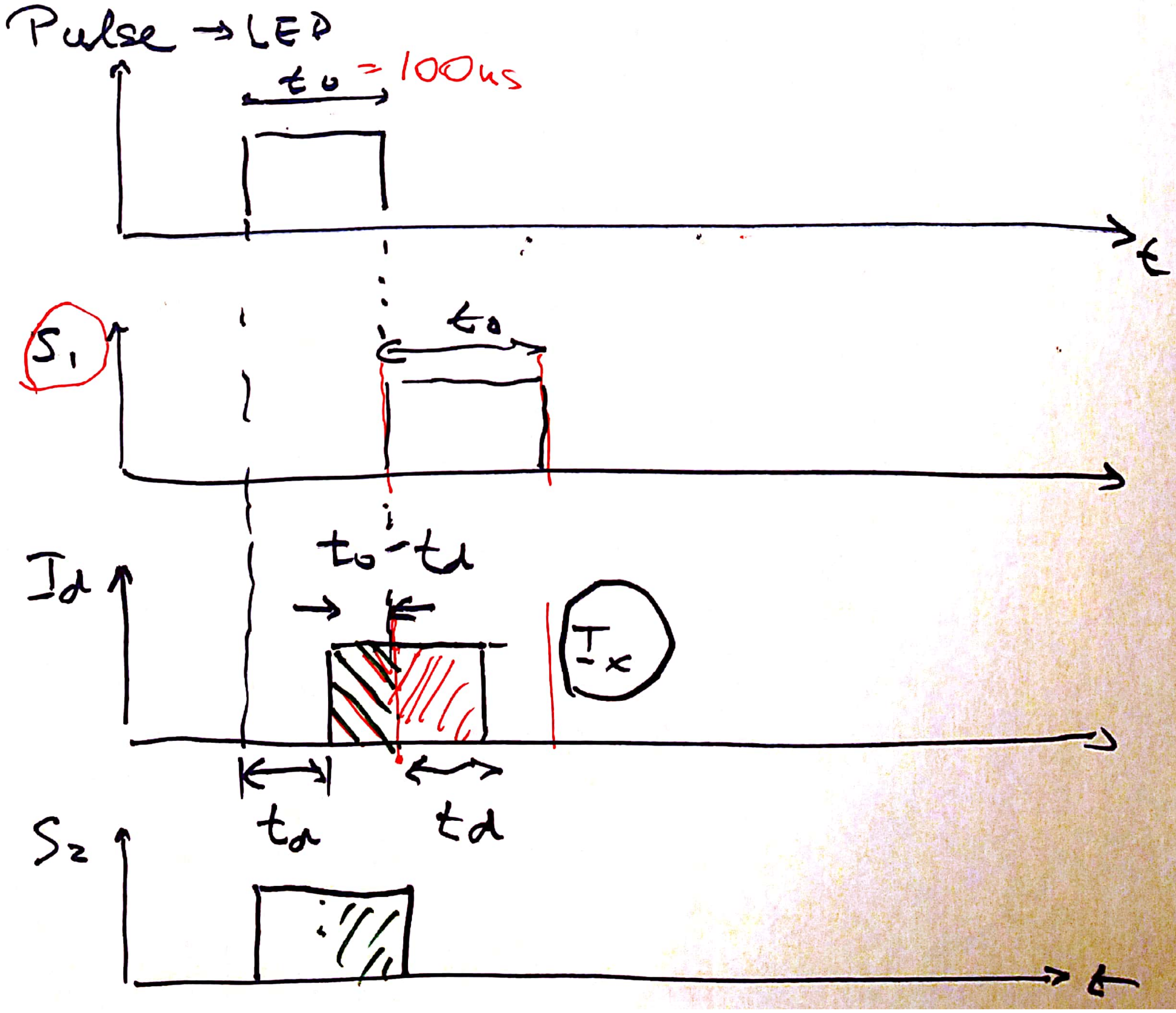
$$= 6.7 \cdot 10^{-9} \text{ sec}$$

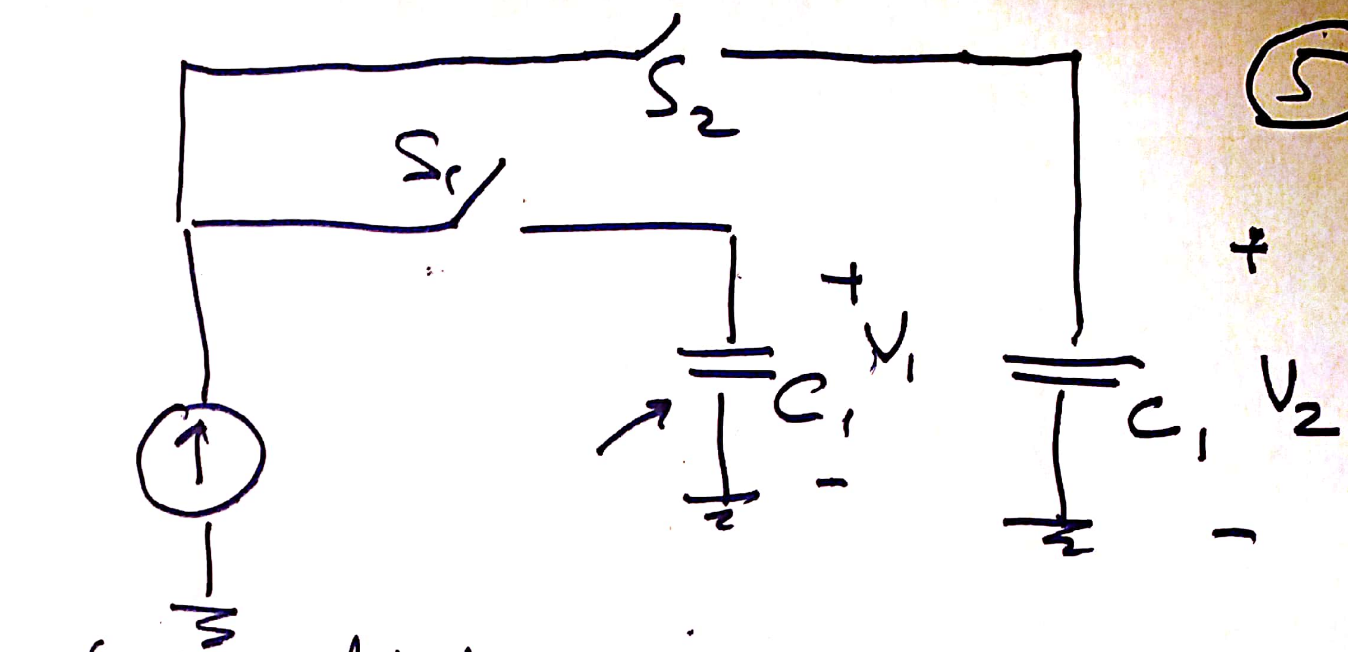


$$q_1 = t_d \cdot I_x$$

$$= \frac{2 \cdot D}{c} \cdot I_x$$


Ix
S1
C1
Photo diode


Pulse → LED
t0 = 100us
t
S1
t0
Id
t0 - td
Ix
td
td
S2
t



$$q_1 = I_x \cdot t_d = \frac{2D}{c} \cdot I_x$$

$$\Rightarrow V_1 = \frac{q_1}{C_1} = \frac{I_x \cdot t_d}{C_1}$$

$$q_2 = I_x \cdot (t_0 - t_d) \qquad t_d = \frac{2 \cdot D}{c}$$

$$\Rightarrow V_2 = \frac{I_x}{C_1} \cdot (t_0 - t_d)$$

$$\therefore D = \frac{c \cdot t_0}{2} \cdot \frac{V_1}{V_1 + V_2}$$

Next: 166

* Devices : Transistors, LED, ...

EE 130 : Integrated Circuit Devices

EE 143 : Microfabrication

* Circuits :

Analog : EE 105 Microelectronic Devices & Circuits

Digital : EECS 151 Digital Design

Signals :

EE 120 :

Signals & Systems

Computing

61 ABC

ML, AI

- Devices:
  - EE 130, Integrated Circuit Devices
  - EE 134, Fundamentals of Photovoltaic Devices
  - EE 143, Microfabrication Technology
  - EE 147, Micromechanical Systems
- Circuits:
  - Analog: EE 105, Microelectronic Devices and Circuits
  - Digital: EECS 151, Digital Design and Integrated Circuits
- Signals
  - EE 120, Signals and Systems
- Computing
  - CS 61 A/B/C

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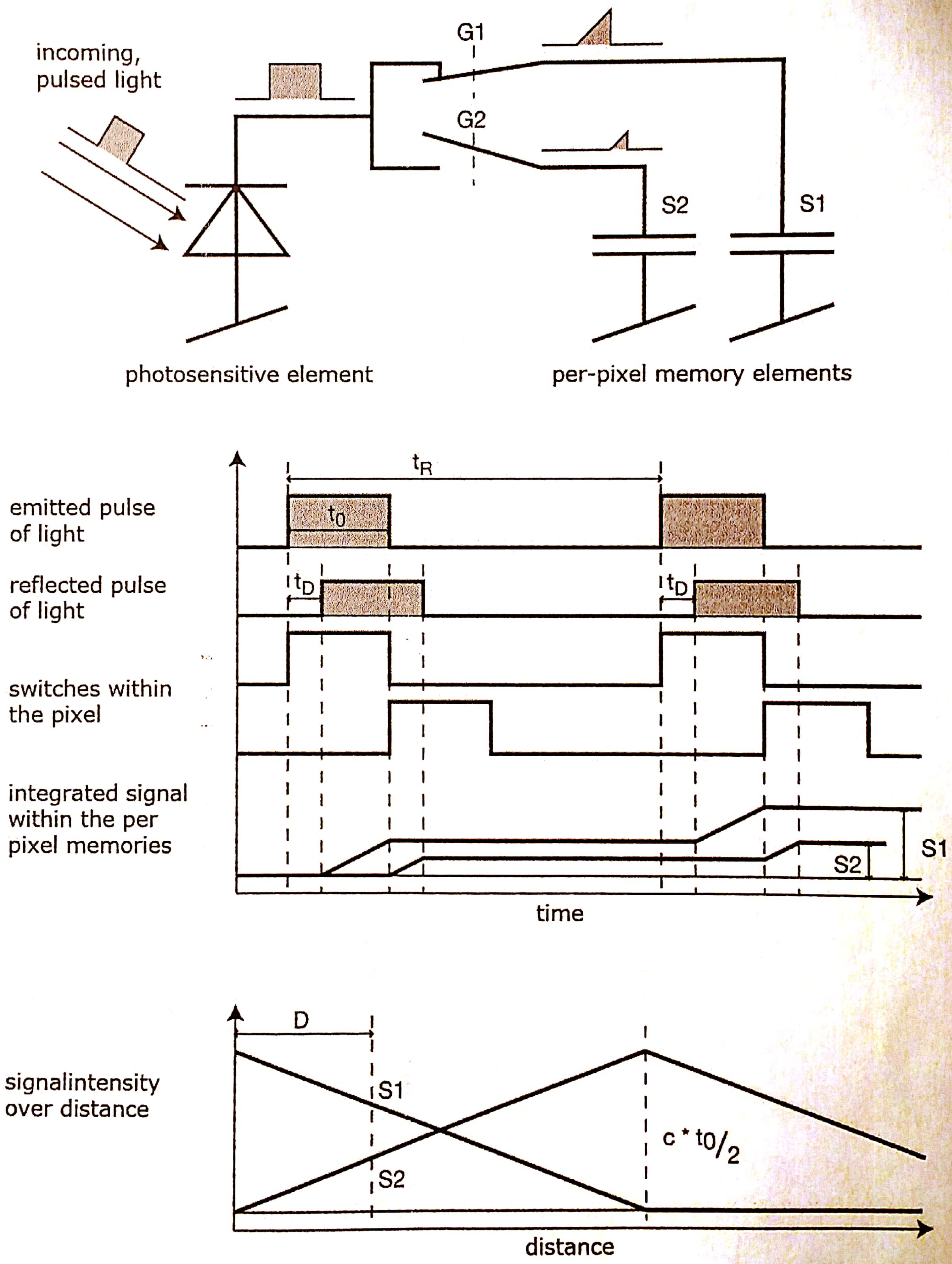
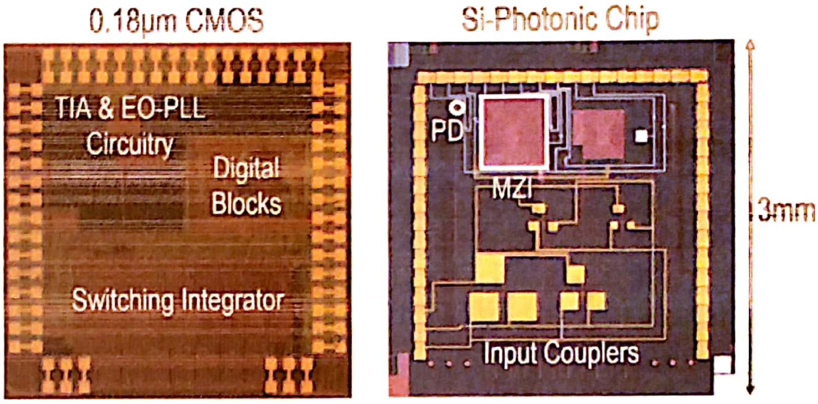
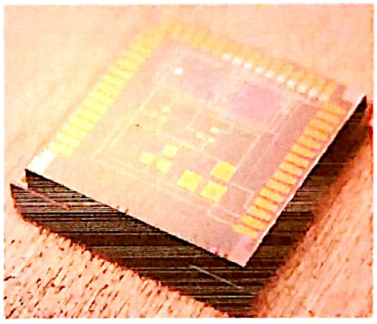
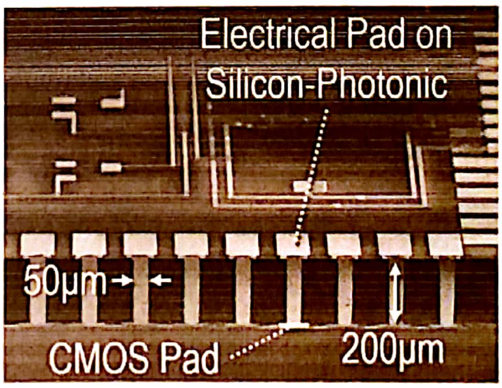

incoming, pulsed light
G1
G2
S2
S1
photosensitive element
per-pixel memory elements
emitted pulse of light
reflected pulse of light
switches within the pixel
integrated signal within the per pixel memories
time
signalintensity over distance
distance
D
c * t0/2



(a) Chip photomicrographs.



(b) Photograph of the integrated stack.



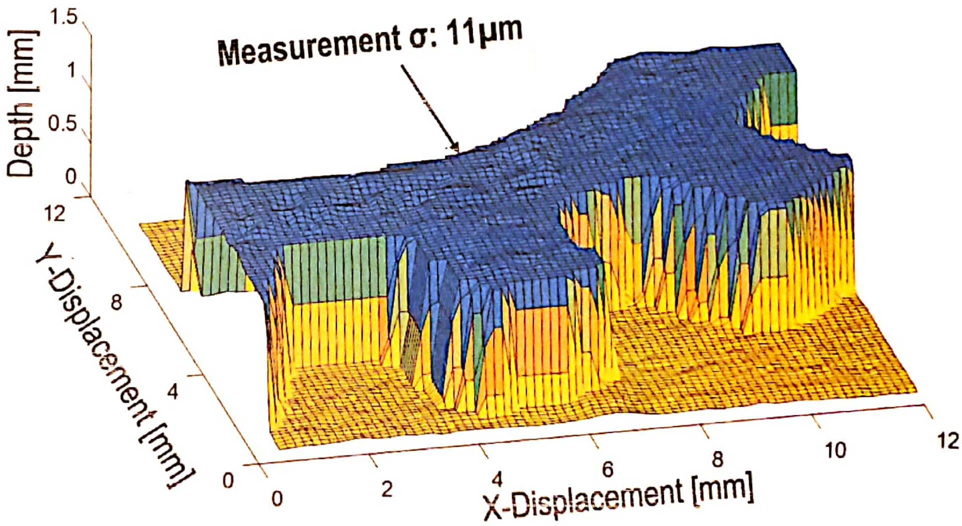
(c) Tilted SEM of the Integrated stack diced at the position of the TSVs.

Figure 1.19. Electronic-Photonic integrated implementation of the EO-PLL.

3.6 Experimental Results

The performance of the EO-PLL is quantified by measuring the error on the modulation slope, γ. The output frequency of the MZI beat signal is proportional to γ and is measured to determine its value. For this purpose, the square-wave voltage at the TIA output on the CMOS chip is recorded

(a) Photograph.



(b) 3D image.

Figure 1.23. Photograph and 3D image of a miniature gear acquired using the measurement setup in Figure 1.21.

1.5 Conclusion

A comparison between the results of this work and other ranging and 3D imaging techniques is presented in Table 1. The integrated EO-PLL presented in this work, enables 3D imaging with micrometer-level precision in a chip-scale platform. In addition to numerous applications in manufacturing industries, this work enables further application of 3D micro-imaging in a wider range of fields, such as miniature 3D imagers for robotic microsurgery devices and corneal imaging for contact lens fitting in medical fields, and high-fidelity 3D copy machines for rapid prototyping.