IDEC Chip Design Contest

A 128-channel CMOS Optoelectronic Receiver IC Array for Short-Range LiDAR Sensors

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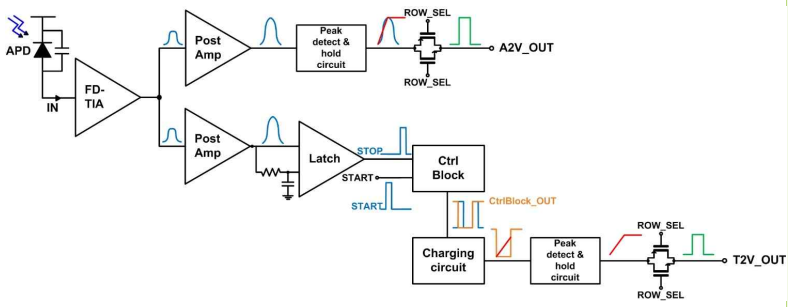
Introduction

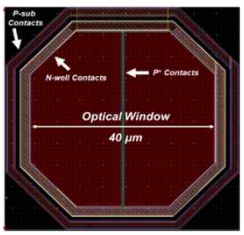
- **Short-range LiDAR sensors**
  - ✓ LiDAR optoelectronic AFE for monitoring the elderly people in home-environments
  - ✓ Time-of-Flight (ToF) mechanism for real-time range detection
  - ✓ Compact, low-power, low-cost solution required
  - ✓ Detection range: 33.7 cm to 18.4 meters

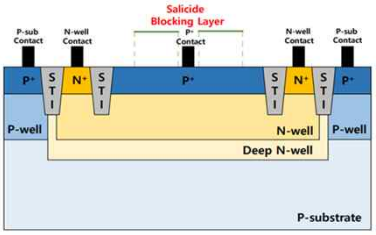
OEIC Architecture



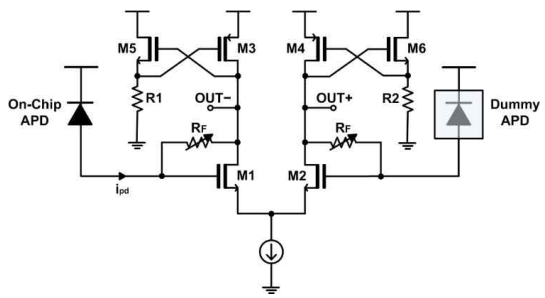
- **CMOS 128-channel Optoelectronic Receiver Array (ORA)**
  - ✓ An amplitude-to-voltage (A2V) detects and amplifies small input currents
  - ✓ A time-to-voltage (T2V) measures large photocurrents based on time intervals
  - ✓ On-chip P⁺/NW/DNW CMOS APD lowers cost and simplifies integration

- **On-chip P⁺/NW/DNW APD**



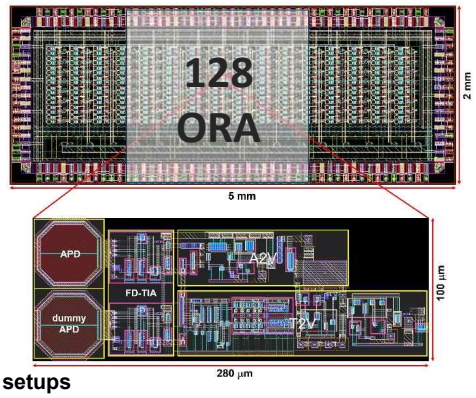


  - ✓ Photocurrents extracted from P⁺ contacts
  - ✓ N-well contacts tied to AC-ground
  - ✓ Shallow Trench Isolation (STI) exploited as guard ring
  - ✓ Octagonal design to avoid edge breakdown
  - ✓ Diameter of the optical window = 40 μm

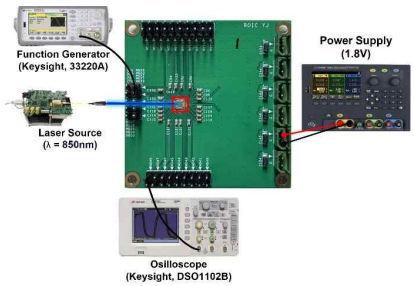


- **Proposed Fully Differential TIA (FD-TIA)**
  - ✓ Cross-coupled NMOS source-follower incorporated to boost the output swing
  - ✓ Differential transimpedance gain as high as the feedback resistor (R_F)
  - ✓ Dummy APD exploited for the circuit symmetry
  - ✓ Variable feedback resistor for extended dynamic range

Chip Photo

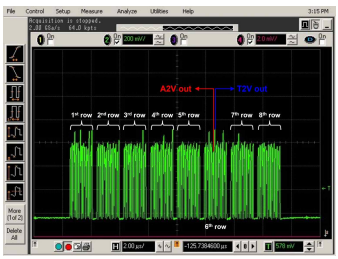


- **Test setups**

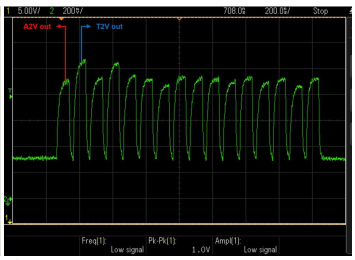


Measured Results

- **Output Signal**



✓ 8-row outputs



✓ single-row outputs

Performance Summary

Parameters	This work
Technology (μm)	0.18 CMOS
# of channels	128
Input current range	1.0 μA_{pp} ~ 1.1 mA_{pp}
A2V Range	2.61 ~ 18.4 meters
T2V Range	0.337 ~ 2.92 meters
Power dissipation (per channel)	10.1 mW
Core area (mm^2)	280 x 100 μm^2

Acknowledgments

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