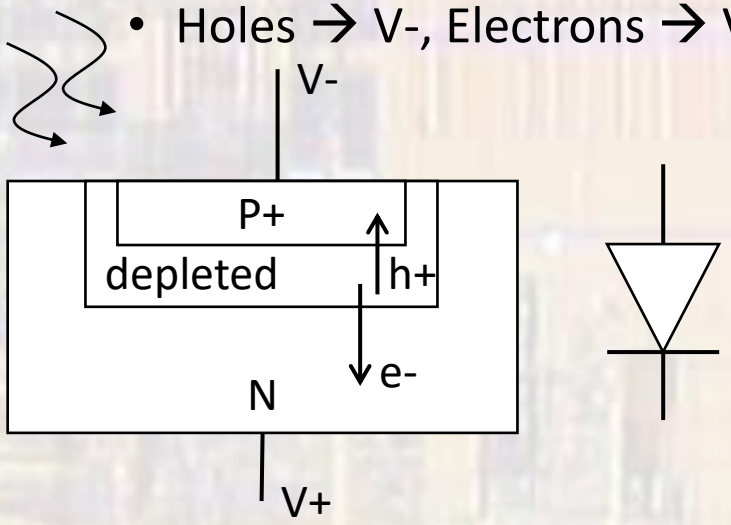
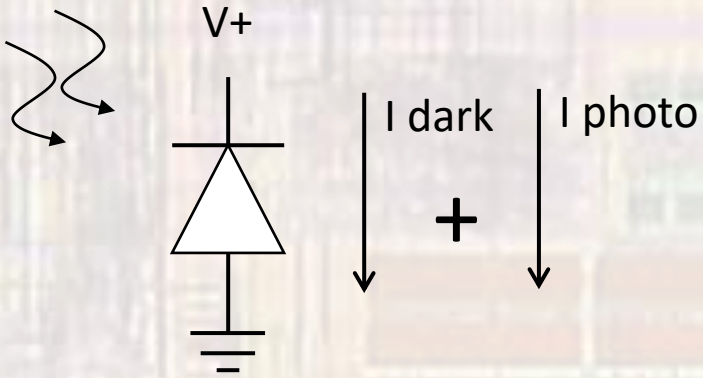
# Photo-Diode Imagers

3/20/24

# Photo-Diode Imagers

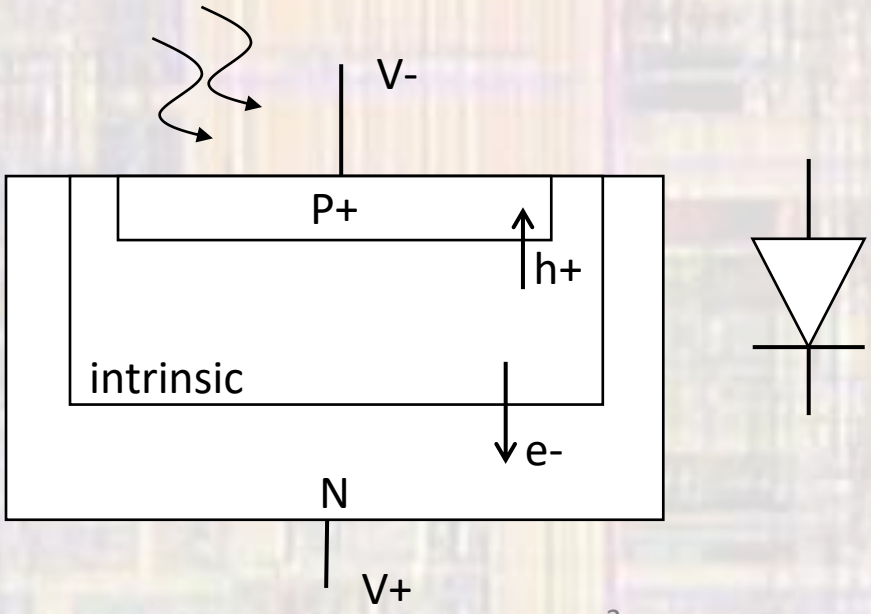
- Photo-diode
  - Reverse bias the junction (leakage current == dark current)
  - Light creates hole-electron pairs
  - h-e pairs immediately recombine in P+ and N regions
  - h-e pairs in the depletion region are swept to the P+ and N regions
    - Holes → V-, Electrons → V+ → increase in reverse current



# Photo-Diode Imagers

- Photo-diode
  - Depletion region is not very large → limited performance
  - PIN diode
    - Add an intrinsic region to increase the h-e generation volume



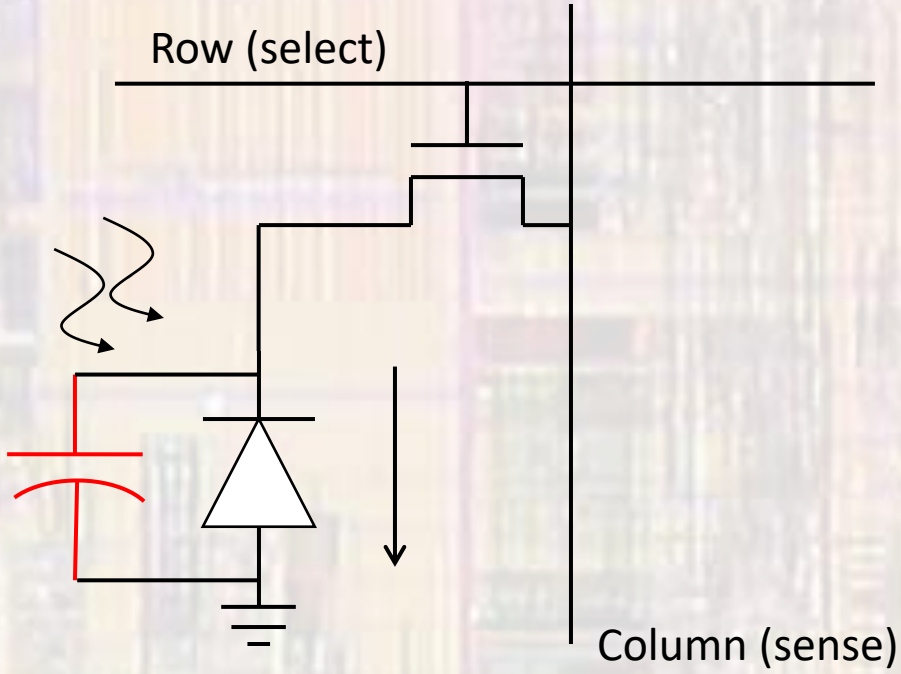
# Photo-Diode Imagers

- Photo-diode

| Material | Properties | Sensitivity | Usage |
|---|---|---|---|
| Silicon | low dark current, high speed | 400 and 1000 nm | visible |
| Germanium | high dark current, slow speed | 900 and 1600 nm | infrared |
| Indium Gallium Arsenide Phosphide | low dark current, high speed | 1000 and 1400 nm | |
| Indium Gallium Arsenide | low dark current, high speed | 900 and 1700 nm | |

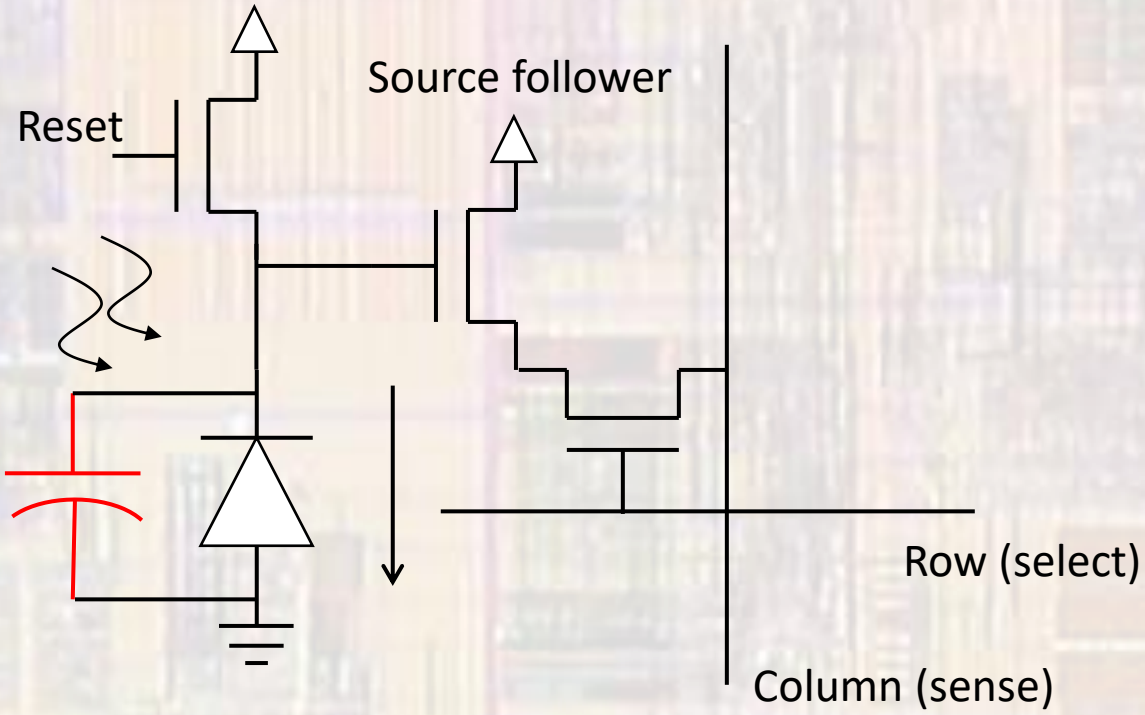
# Photo-Diode Imagers

- Passive Pixel Sensor
  - Simple and small
  - Poor performance



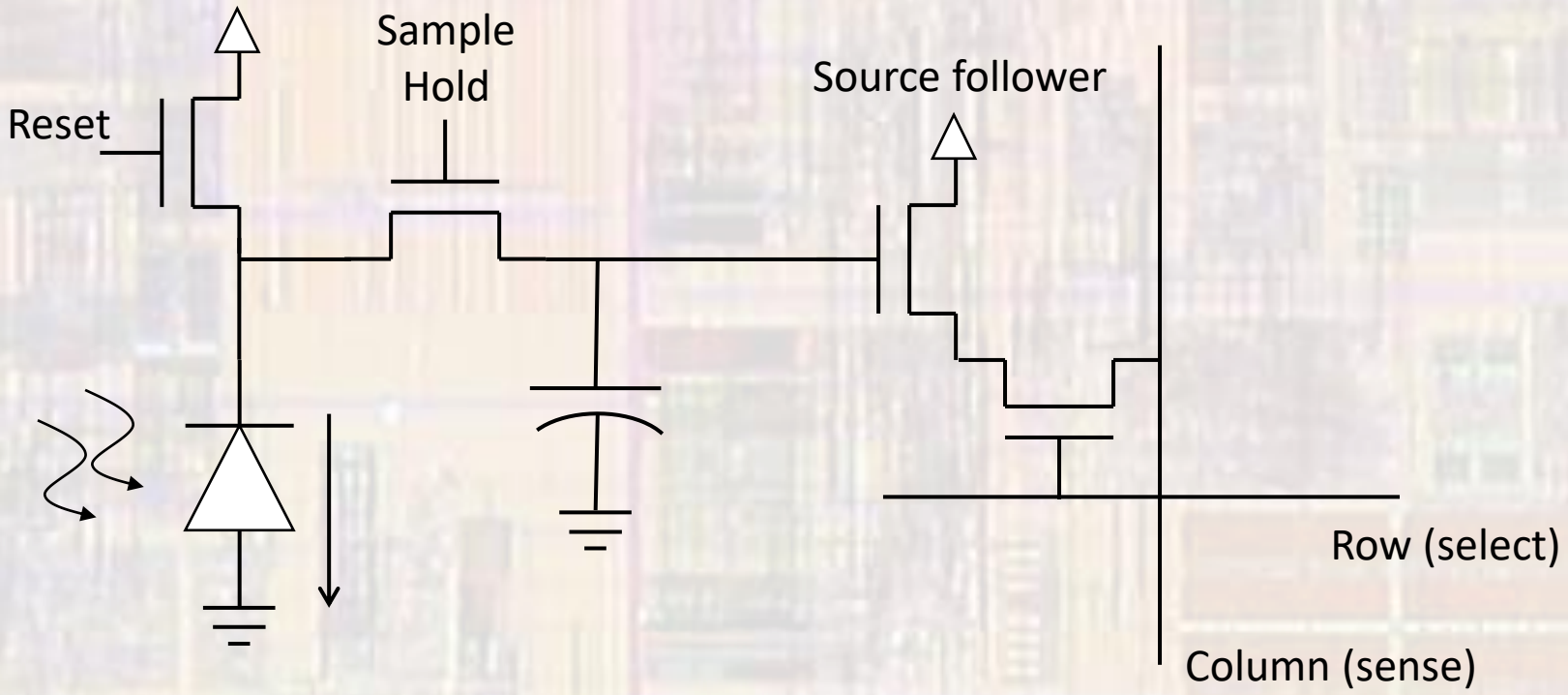
# Photo-Diode Imagers

- Active Pixel Sensor (APS)
  - Reset – fully charges the parasitic capacitance
  - Light – discharges proportional to the intensity and length of exposure



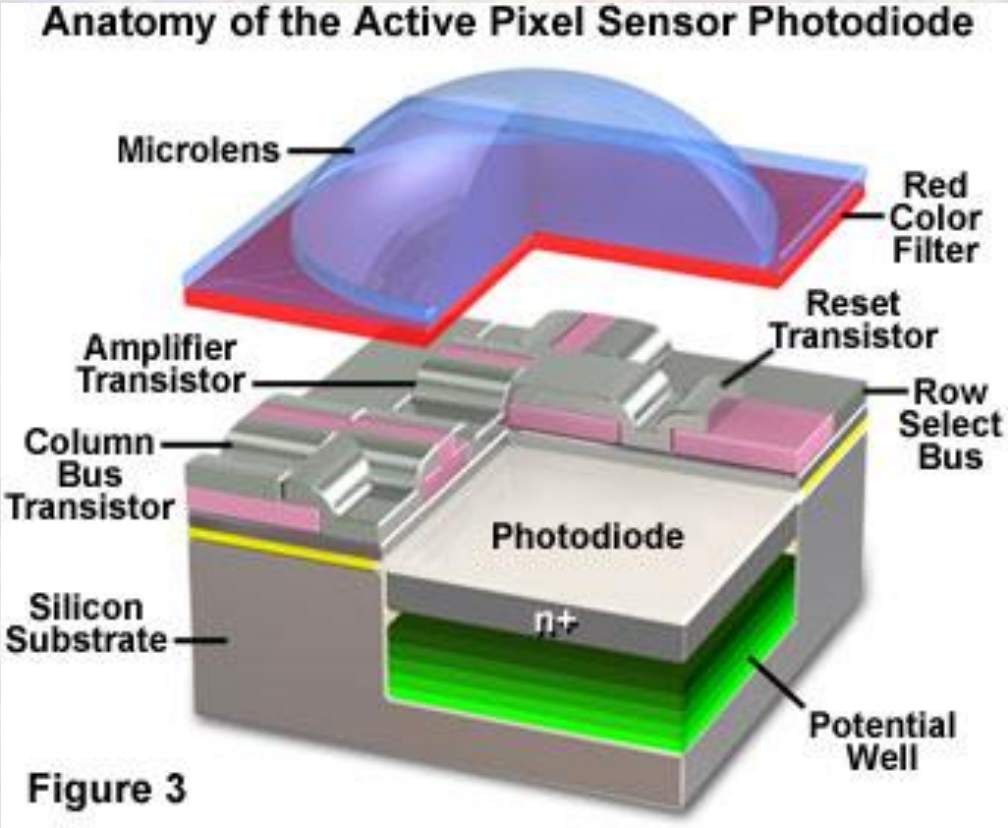
# Photo-Diode Imagers

- Active Pixel Sensor (APS)
  - 4T structure
  - Allows an electronic shutter (S/H)



# Photo-Diode Imagers

- Active Pixel Sensor (APS)




Src: http://micro.magnet.fsu.edu/

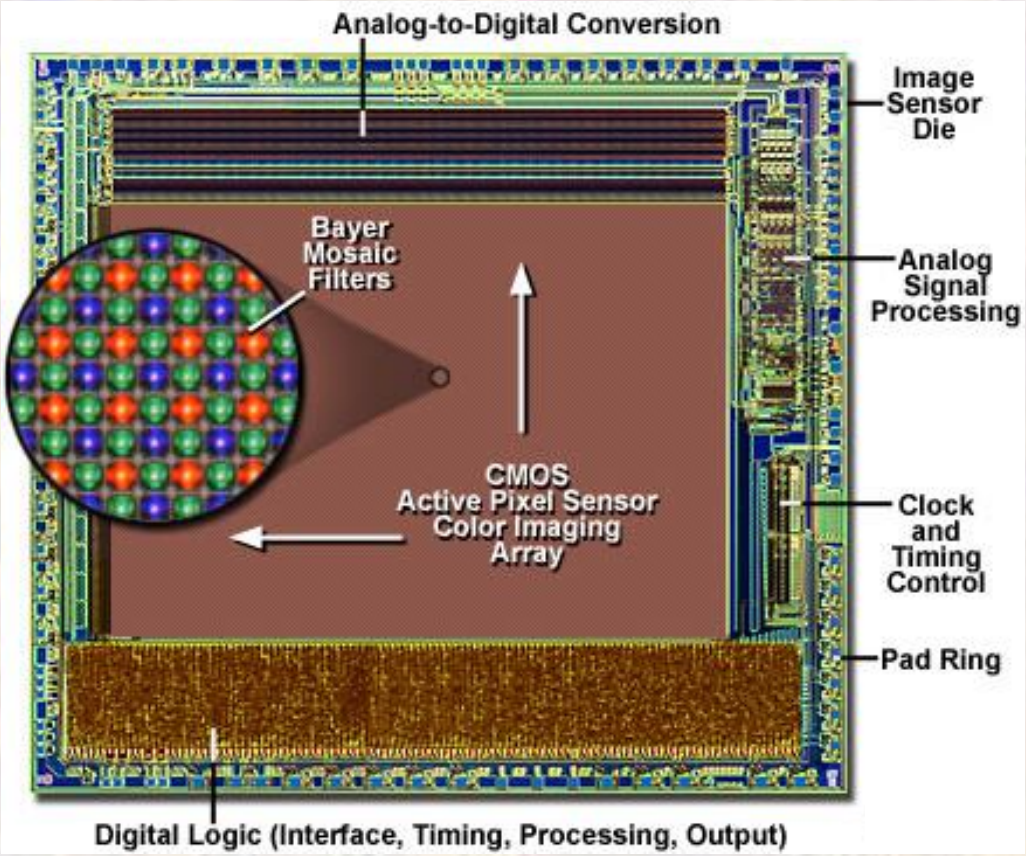
# Photo-Diode Imagers

- Active Pixel Sensor (APS)


Src: http://micro.magnet.fsu.edu/

# Photo-Diode Imagers

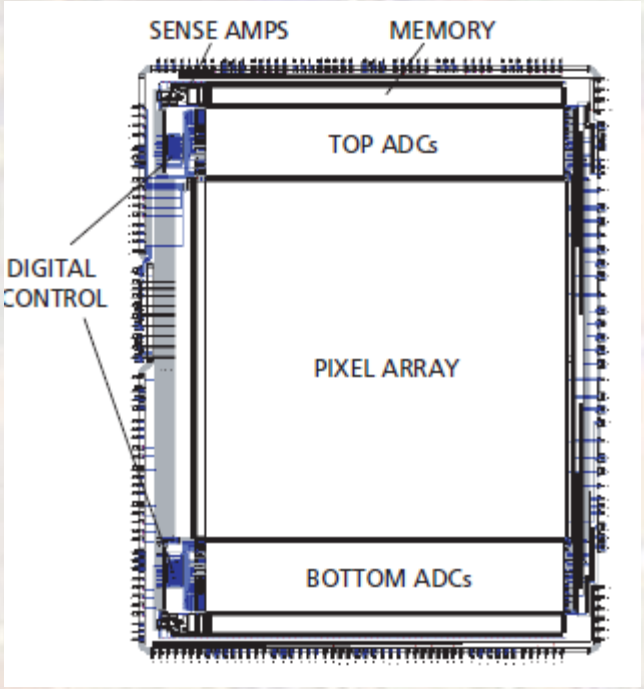
- Active Pixel Sensor (APS)

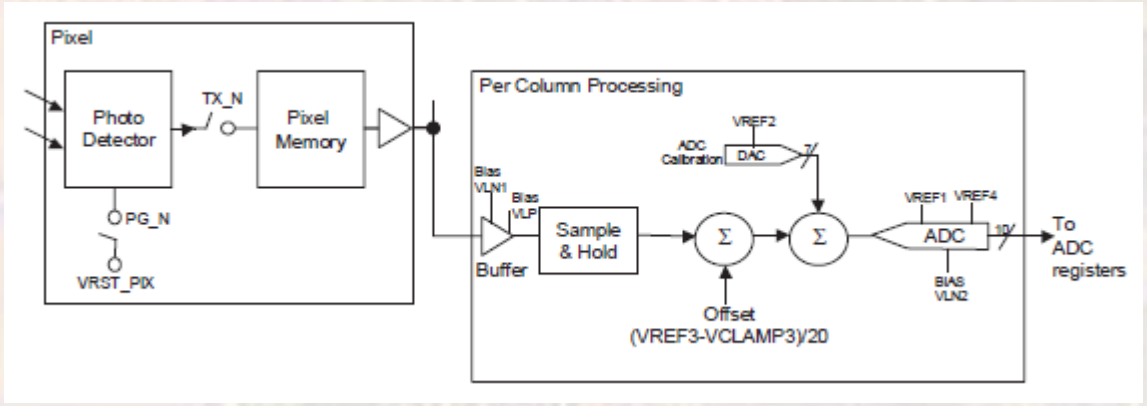



Src: http://micro.magnet.fsu.edu/

# Photo-Diode Imagers

- Active Pixel Sensor (APS)




Src: micron

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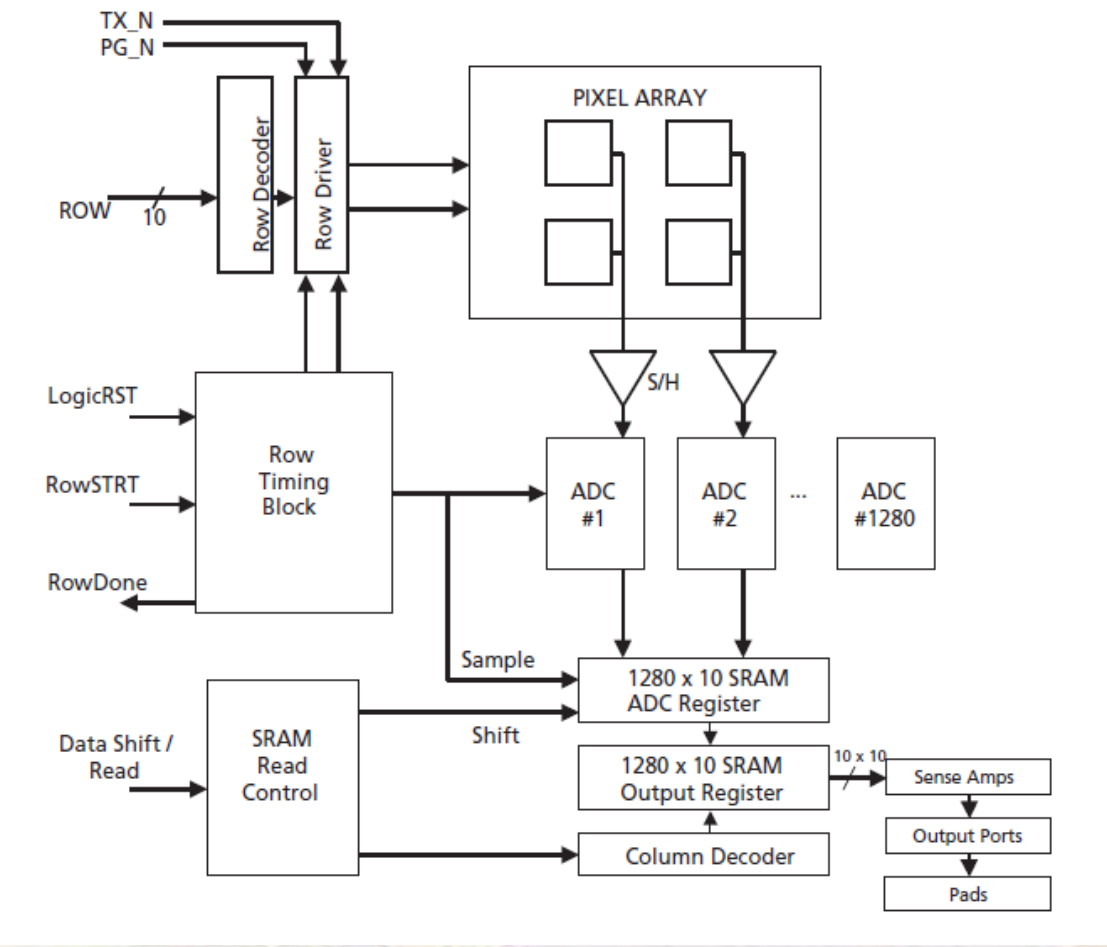
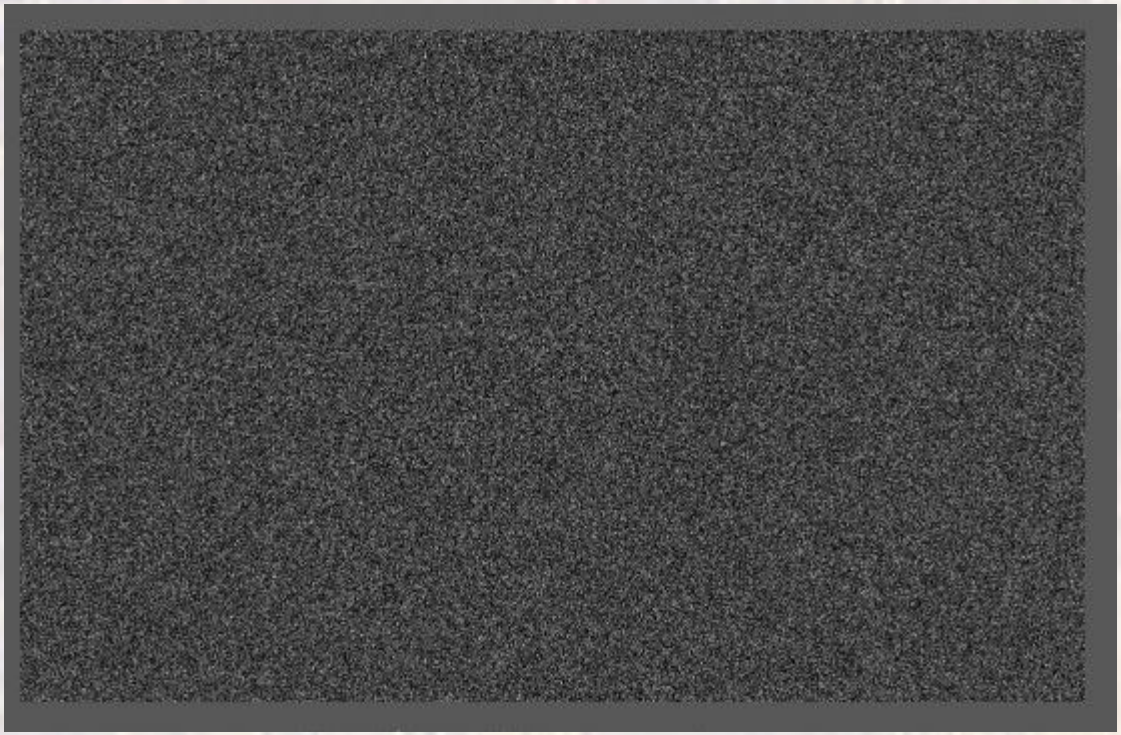
- Active Pixel Sensor (APS)




Src: micron

# Photo-Diode Imagers

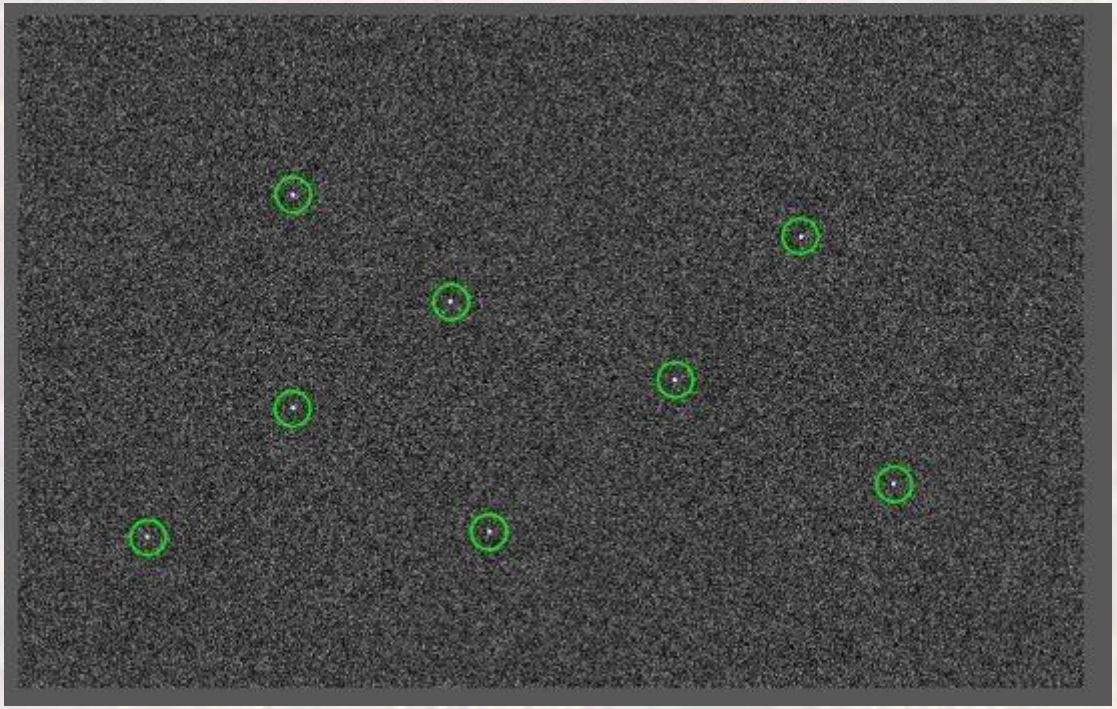
- Active Pixel Sensor (APS)
  - Dark Noise



Src: exclusive architecture

# Photo-Diode Imagers

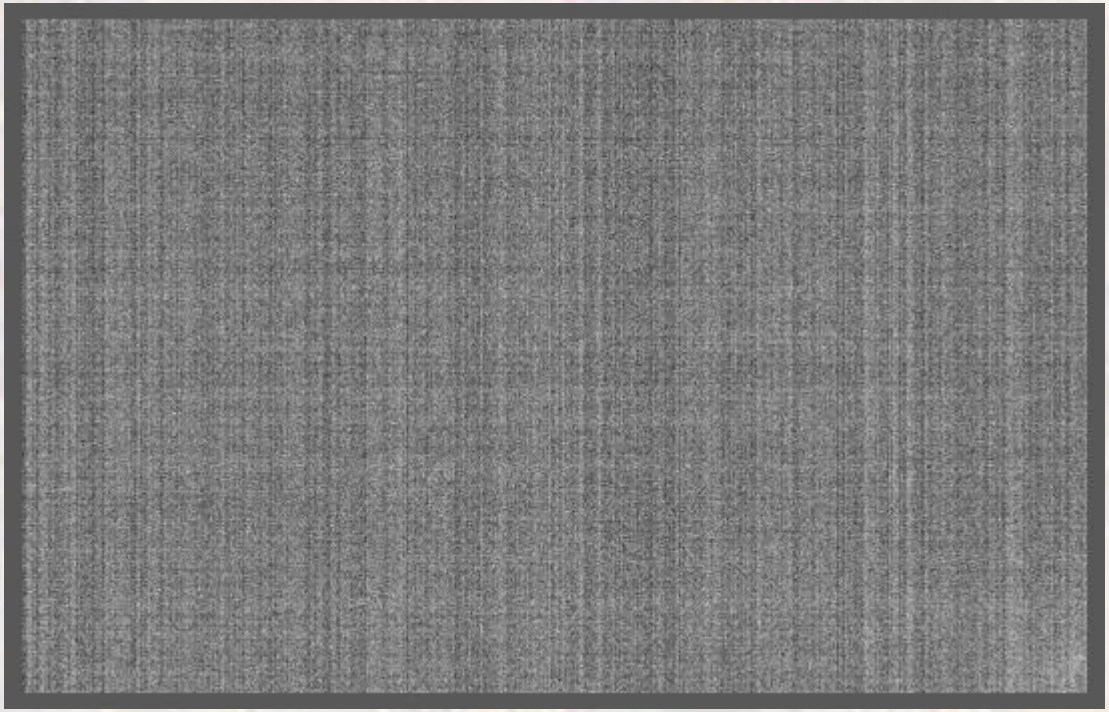
- Active Pixel Sensor (APS)
  - Fixed Pattern Noise
    - Especially sensitive diodes



Src: exclusive architecture

# Photo-Diode Imagers

- Active Pixel Sensor (APS)
  - Banding Noise
    - Readout electronics patterns



Src: exclusive architecture

# Photo-Diode Imagers

- 120Mpixel Imager

Src: smarttechnologynow