EXCELITAS TECHNOLOGIES®

ENABLING THE FUTURE THROUGH LIGHT

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Photon Detection – Saving Lives Through Precision and Protection

Richard Simons

Product Manager – Defense Sensors and Low-Light-Level Detection

EXCELITAS TECHNOLOGIES

Excelitas...About Us

EXCELITAS TECHNOLOGIES

Revenues of ~$1.1 Billion in 2022

- **Commercial SBU** (~$800M) focused on life sciences, industrial manufacturing, smart building and semiconductor market sectors
- **Defense & Aerospace SBU** (~ $300M) focused on avionics, C5ISR, HMD/HUD, missiles/missile defense, satellites and soldier systems

Headquartered in Waltham, MA USA

Defense and Aerospace Applications We Serve


Dismounted Soldier


Missiles/PGM/Missile Defense


Airborne C5ISR


Surveillance


Civil Avionics


Vehicle Optronics


Defense Avionics


Space

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Defense and Aerospace Sensors – end applications

Laser Range Finding	Proximity Sensing	Laser Warning Receiver	Terminal Guidance	Space Based GPS & LIDAR

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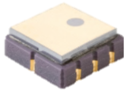
A diverse portfolio of emitters and detectors for laser systems and applications

Capabilities – Defense Sensors

Technology & Qualification

Si
InGaAs
PIN, APDs
Lasers
IR Sensor
Analog Modules






Internal Qualification capabilities:
- MIL-PRF-19500 or MIL-PRF-38354
- Screening
- Group A
- Group B
- Group C

Wafer Fabrication

Thermal Processing
- SiO_2 thermal growth
- Solid/liquid sources for B,P

Deep reactive ion etching (DRIE)
- Etch rate 10 µm/min
- Uniformity 1%
- Aspect ratio 50:1

Photolithograpy
- Contact Proximity: Resolution 2µm, Precision 0.5µm
- Projection: Resolution 0.5µm, Precision 0.1µm



Epitaxy (III-V)
- MOCVD : Metal-organic vapor-phase epitaxy

Ion Implantation
- Dopants B, P, As, Ar
- Dose 10^{11} - $3x10^{15}$ cm^{-2}

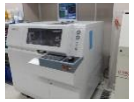
Chemical Vapor Deposition (CVD)
- SiO_2 LTO (AP,LP,PE)
- Si_3N_4 (LP,PE)

Physical Vapor Deposition
- Sputtered films Al, TiW, Au, Ti, Cr
- Evaporated films Al, Cr, Pd, Ni, Ag, Au, Ti, SiO

Etching
- Wet etch: SiO_2, Si_3N_4 polysilicon, metals
- Dry etch: SiO_2, Si_3N_4 polysilicon

Assembly & Test

Chip Inspection
- Auto probing
- Wafer mapping/binning



Pick and Place
- Automated processing
- Enables binning

Stealth Dicing
- Increased yield
- Enables complex shape

Wafer & Chip Dicing & Testing
- SiO_2 thermal growth
- Solid/liquid sources for B,P



Automated mounting and bonding
- High precision
- High throughput


Sealing
- Seam sealing
- Projection welding

Final Test and Inspection
- Automated data collection
- Real time SPC

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How do we keep our troops safe?

1. Engage at a distance, catch the enemy by surprise

2. Don’t get caught by surprise

1. Clubs are better than fists, swords are better than knives
   Spears are better than both, arrows even better
   Guns, artillery, rockets, missiles
   Hit the target first time

2. Don’t get snuck up on
   See the enemy coming, react appropriately….

- How does detecting photons help with these 2 challenges?
  - Precision-guided munitions
    - Laser guided munitions home in on a laser beam designating (pointing at) the target (requires a detector in the munition, separate system for emitter)
  - Laser range finding
    - Measuring distance through time-of-flight calculation of laser pulse (requires an emitter and a detector in the same system)
    - Also used in proximity fuzing (sends a signal to detonate the warhead at predefined distance from its target)
  - Laser warning receivers
    - Detect and determine relative direction of laser designator beam (angle-of-arrival or AoA) lasing a platform (requires detector)

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Precision-Guided Munitions

A precision-guided munition (smart weapon, smart bomb) is a guided munition intended to precisely hit a specific target, to minimize collateral damage and increase lethality against intended targets.

A laser designator is used to “paint” the target – this can be from the ground, or airborne from the launch aircraft or from a separate aircraft.

The detector at the front of the munition detects the signal from the laser and the electronics control movable fins to steer the munition to the target

Paveway, followed on from BOLT, and used front steering canards for greater precision and range. First used in combat also in 1968, derivatives still in use today.

BOLT-117, the world's first laser-guided bomb, at the National Museum of the United States Air Force.

The seeker at the front sends signals to the control fins at the rear.

Developed by Texas Instruments, starting in 1964, first tested in April 1965, and first used in combat in May 1968, with the WSO in the rear seat of a Phantom F-4 using a hand-held laser designator.

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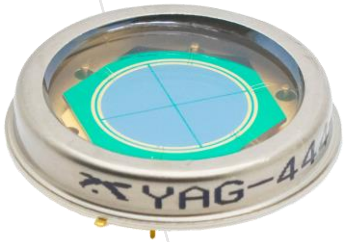
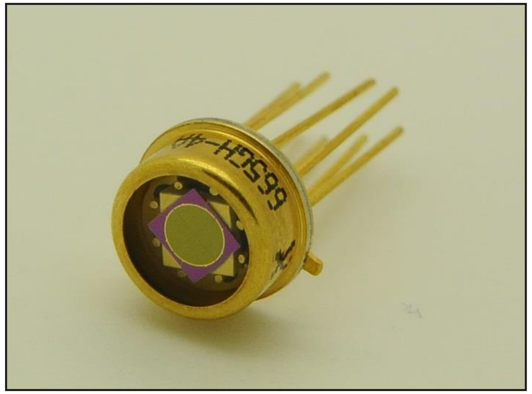
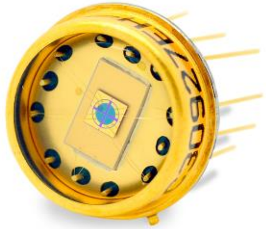
Paveway III seeker head on GBU-24

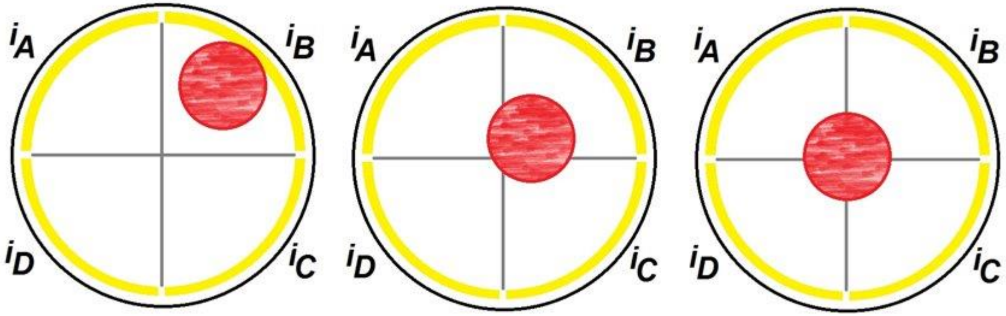
A laser-guided GBU-24 Paveway III

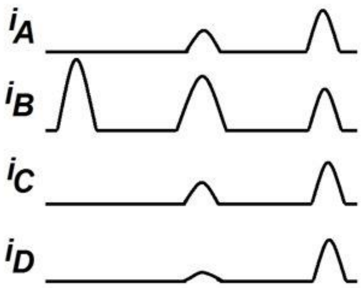
Precision Guided Munitions – Quadrant photodiodes











$$X = \frac{(i_A + i_D) - (i_B + i_C)}{i_A + i_B + i_C + i_D}$$

$$Y = \frac{(i_A + i_B) - (i_C + i_D)}{i_A + i_B + i_C + i_D}$$

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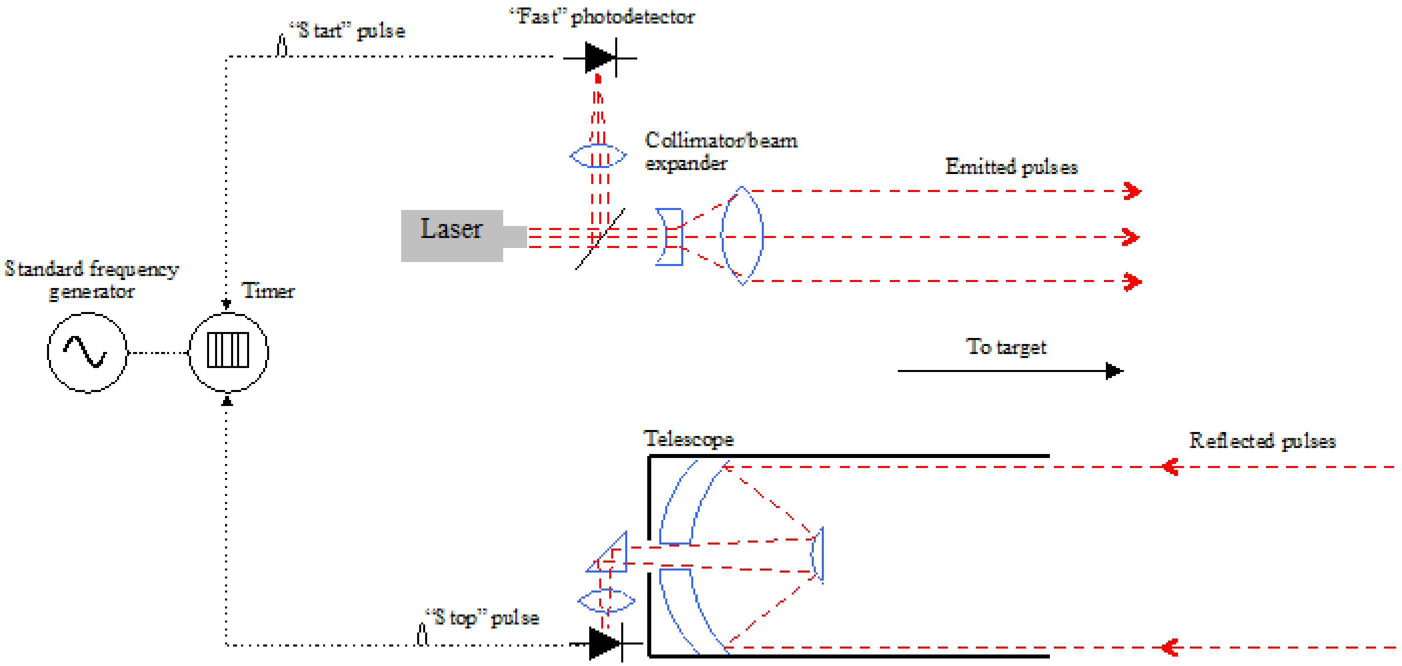
Laser Range Finding



Direct Time of Flight

- D = ct/2n
- Because of time jitter in the photodetectors, variations in rise times, and electrical noise in the pulses, the timer does not measure a constant TOF *t* – thus there is δ_t – even though the target is stationary.
- δD ≈ cδt/2n
- If δt is 1ns then δD ≈ 15cm
- Good at distance, even for moving objects if reasonable reflectivity

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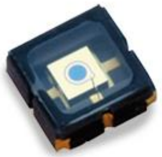
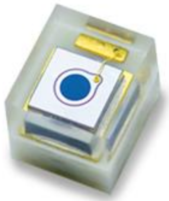
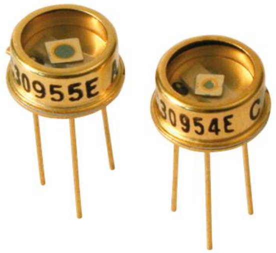
Laser Range Finding







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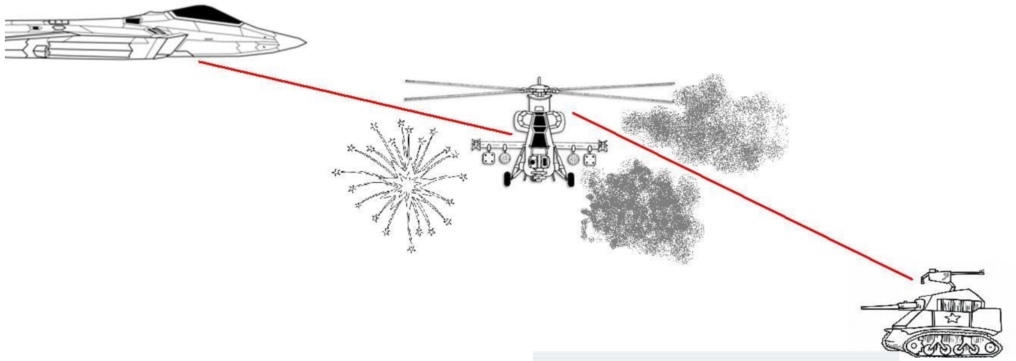
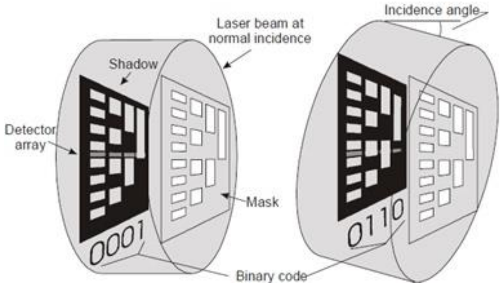
Laser Warning Receivers





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