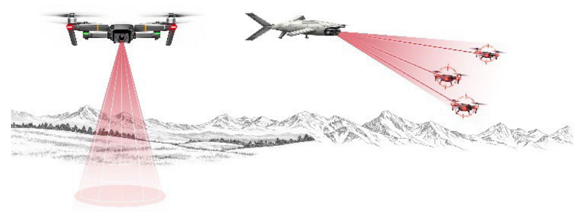
White Paper

AFBR-S50

Enhancing Drone Autonomy with Broadcom Time-of-Flight Sensors



Introduction

In the rapidly evolving landscape of unmanned aerial vehicles (UAVs), precision and reliability in spatial awareness are the cornerstones of operational success. Whether navigating the steel canyons of an urban construction site, monitoring crops in vast agricultural fields, or counteracting threats from other UAVs, drones require sensors that can perform under extreme ambient conditions. The Broadcom AFBR-S50 family of time-of-flight (ToF) sensors provides a high-performance, multipixel solution that is designed to meet these challenges. By offering exceptional ambient light suppression (up to 200 klx) and a lightweight, compact form factor (< 1g), the AFBR-S50 series empowers drones with the *sight* necessary for safe, autonomous flight across all industrial sectors.

Table 1: Technological Comparison of Sensor Types

Feature	ToF (Optical)	Radar (mmWave)	GNSS (GPS)
Best-in-Class Feature	Perfect landings, visual navigation, and triggering	Sensing in all-weather conditions possible	Global, absolute positioning
Indoor/GPS-Denied	Excellent	Good	None
Accuracy/Resolution	Very high	Coarse	Low – missing line-of-sight to space
Update Rate	Very high	Medium	Low
Security (Jamming)	Highest – nearly impossible to disrupt signal	Medium-low (suppression and spoofing possible)	Low (suppression and spoofing easily possible)

Based on the comparison provided, it is clear that ToF technology is the superior primary choice for the critical, high-stakes maneuvers of modern drone operations, such as autonomous navigation, precision targeting, and landing. Although GNSS provides a global coordinate system and radar offers a secondary safety layer for weather penetration, ToF remains a cornerstone of spatial awareness for the following reasons:

- Unmatched precision and speed
- Fail-safe for GPS-denied environments
- Lowest jamming vulnerability
- Optimal mission reliability

Drone Use Cases

This section summarizes the primary use cases for ToF sensors in drone applications including the required key characteristics.

Landing Support

The AFBR-S50 provides high-precision distance measurements to the ground, ensuring a controlled and cushioned touchdown even on varied or light-absorbing surfaces in a GPS-denied environment. Its terrain-agnostic nature allows the flight controller to maintain an accurate altitude-above-ground estimate during the critical final meters of descent.

Key Characteristics

- Long-distance measurement
- Strong sunlight immunity
- Reliable measurements against all ground types

✓ Fulfilled by AFBR-S50 ToF sensors.

Altitude

Collision Avoidance

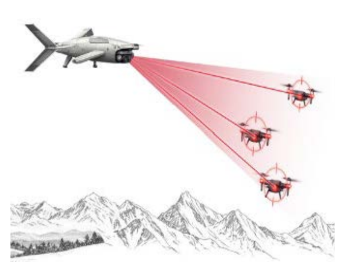
The sensor utilizes a larger beam divergence to act as a *virtual bumper*, casting a wide detection cone that captures a significant volume of space to identify hazards before they enter the drone's flight path. Engineered for high-reliability outdoor use, its strong sunlight immunity ensures that this protective field remains active and accurate even in direct, mid-day glare that would blind traditional optical sensors.

Key Characteristics

- High accuracy and precision
- Strong sunlight immunity
- High dynamic range

✓ Fulfilled by AFBR-S50 ToF sensors.

Trigger



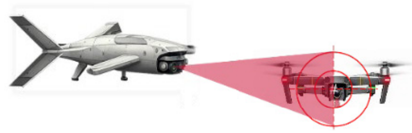
Fast Proximity Detection

This use case is often realized with radar sensor fusion. While radar sensors provide the coarse range of the detected object, the ToF LiDAR provides a low-latency signal to execute high-precision maneuvering when rapidly approaching other drones or obstacles. The ultra-high frame rate of up to 3 kHz is key for high-speed drones that require immediate and reliable decision-making or course correction when entering a proximity threshold.

Key Characteristics

- High sensor frame rates
- Strong sunlight resistance
- Minimum false-positive detections

✓ Fulfilled by AFBR-S50 ToF sensors.



Visual Odometry

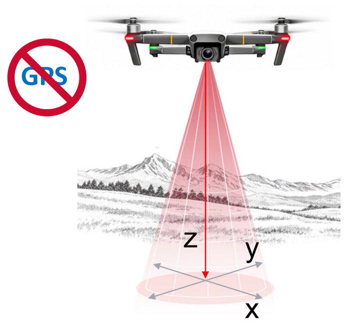
Often integrated into a navigation suite, the sensor provides the high-frequency depth data necessary for ground-truth visual-inertial systems and to prevent drift. This enables precise *position hold* and stable hovering in GPS-denied areas by tracking the relative distance to floors or walls with millimeter accuracy. (Also known as offline navigation for indoors and outdoors in GNSS-denied and jammed environments.)

Key Characteristics

- Long-distance measurement
- Strong sunlight immunity
- Terrain independence

✓ Fulfilled by AFBR-S50 ToF sensors.

Visual Navigation



Laser Range Finders

The narrow field-of-view variants, such as the AFBR-S50LX85D, act as a lightweight laser range finder to provide the exact target distance for camera focus and gimbal stabilization. This allows the payload system to maintain a sharp lock on objects or terrain features even while the drone is in motion.

Key Characteristics

- High accuracy and precision
- Long-distance measurement
- Strong sunlight immunity
- High dynamic range

✓ Fulfilled by AFBR-S50 ToF sensors.

Broadcom AFBR-S50 ToF Family

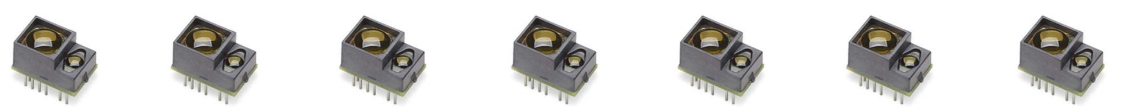
The Broadcom AFBR-S50 family of multipixel ToF sensor modules is shown in Table 2. This family has a distinct modular architecture, which allows users to select specific optical configurations such as ranging from wide-angle, short-range detectors for industrial robotics to narrow-beam or long-range variants for outdoor navigation.

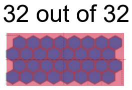
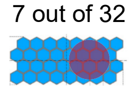
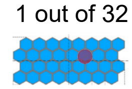
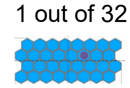
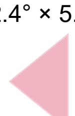
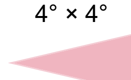
Operating primarily at an 850-nm infrared wavelength (with one variant in the visible-red wavelength at 680 nm), these sensors are engineered to thrive in challenging conditions, maintaining high accuracy even under intense ambient light.

As noted in the Typical Application row, three specific variants are highlighted as the primary choices for the drone industry due to their balance of range and beam precision. Additionally, one variant is generating more interest due to its small beam spot and unique wavelength:

- AFBR-S50LV85D: This variant is optimized for mid-to-long range sensing, offering a 30m typical range and a narrow 2° by 2° field of view (FoV), making it ideal for precision landing support and altitude hold.
- AFBR-S50LX85D: While sharing the same 2° × 2° FoV, this variant is the extra-long-range specialist of the group, capable of reaching 50m typical ranges. Its narrow beam allows for effective obstacle detection at higher flight speeds, giving the flight controller more time to react to distant hazards.
- AFBR-S50EX85D (Upcoming): This upcoming variant is projected to push the range to 100m, which will become the new standard for high-altitude industrial drone sensing.
- AFBR-S50MV68B: This variant has the most reliable spot measurement due to the small laser beam aperture of 0.4°. It is mainly used in trigger applications for drone interception and differs from the other variants in laser wavelength.

Table 2: AFBR-S50 ToF Family – Portfolio Overview



	AFBR-S50MV85I	**AFBR-S50MX85I**	**AFBR-S50MV85G**	**AFBR-S50LV85D**	**AFBR-S50LX85D**	**AFBR-S50EX85D**	**AFBR-S50MV68B**
Typical Range	5m	8m	10m	30m	50m	100m	10m (100m[a])
Range White 1 klx	12m	15m	36m	61m	78m	TBD	36m
Range White 100 klx	3m	4m	12m	18m	22m	TBD	8m
Laser Light Source	850 nm (IR)		850 nm (IR)	850 nm (IR)			680 nm (red)
Typical Number of Illuminated Pixels	32 out of 32 		7 out of 32 	1 out of 32 			1 out of 32 
Usable Sensor FoV	12.4° × 5.4° 		4° × 4° 	2° × 2°			0.4° × 0.4°
Beam Spot Size at 1m	23 × 10 cm^2		7 cm	3.5 cm			0.7 cm
Typical Application	AMRs/AGVs, Factory Automation		Drones, Factory Automation	Drones			Drones, Factory Automation

a. 100m on a retro-reflector.

Key Features of the AFBR-S50 Sensor Family for Drone Applications

	Long range (+100m)
	Ambient light immunity (up to 200 klx)
	High frame rate (3 kHz)
	Compact (no moving parts) and lightweight (< 1g)
	Laser Class 1
	Drop-in compatibility among variants
	Flexible and fully compatible open source API: **GitHub, PX4, ROS 2, ArduPilot**

AFBR-S50 Evaluation Kit and Reference Designs

	AFBR-S50 Family Evaluation Kit (FEK)	**AFBR-S50 Reference Design**	**MikroElektronika**	**ARK Electronics**
				
Product Number/Name	AFBR-S50-FEK	AFBR-S50-RD	BDC-AFBR-S50	ARK Flow, ARK Dist

To implement the Broadcom AFBR-S50 family into a drone platform, designers can choose between entry-level evaluation tools and flight-ready modules. The AFBR-S50-FEK serves as the initial family evaluation kit, providing a socketed STM32-based platform to test all sensor variants via a PC GUI. Moving toward integration, although the AFBR-S50-RD is a suggested reference design with a minimal footprint and a pin header interface, the more versatile BDC-AFBR-S50 board (by MikroElektronika) with solid connectors can be used for both initial evaluation and final product integration. Lastly, for high-performance autonomy, the ARK Flow/Dist represents the most advanced implementation, combining the AFBR-S50 ToF with a PixArt optical flow sensor into a single, open-source DroneCAN module that enables simultaneous precision distance measurement and stable indoor hover.

Contact our sales team to discover how these ToF solutions can optimize your drone applications.

Website:

https://www.broadcom.com/products/optical-sensors/time-of-flight-3d-sensors

GitHub repository:

https://github.com/broadcom/afbr-s50-api

Direct support:

https://engage.broadcom.com/product_support

Video – Time of Flight Sensor in Drone Applications:

https://www.youtube.com/watch?v=4geRJ1Ehx5c