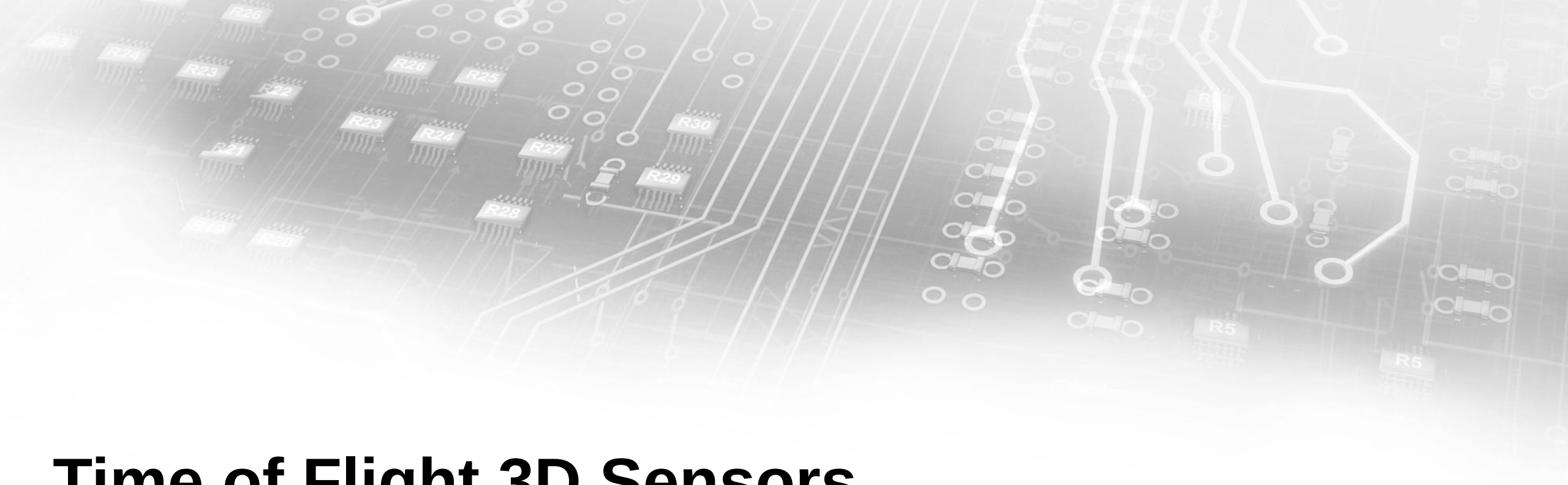

Time of Flight 3D Sensors

Taking Optical Measurement to a New Level

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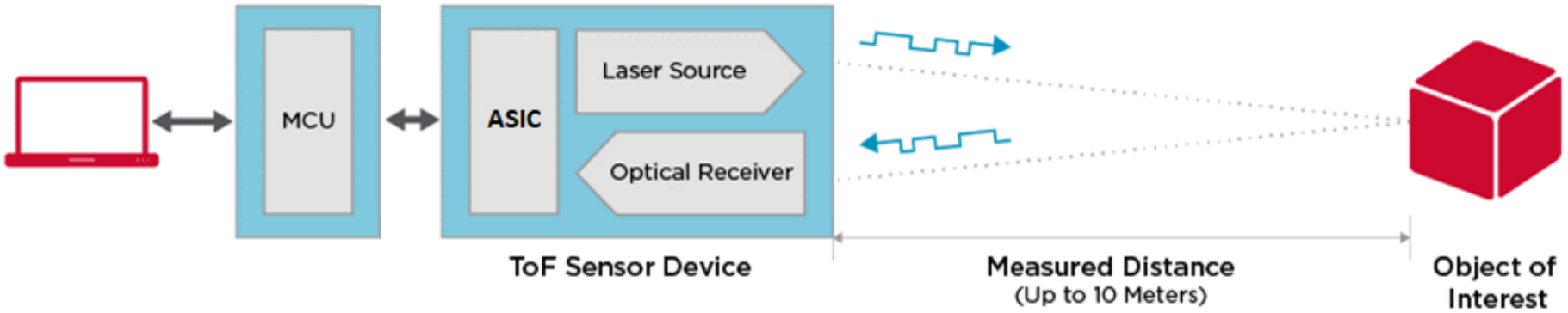
Sebastian Bauer

AFBR – S50 Platform: Measurement Methodology



- The AFBR-S50 is a multi-pixel, optical distance and motion measurement sensor module based on the indirect Time of Flight (ToF) principle
- The sensors contain an integrated laser source, an optical receiver and lenses for beam collimation
- It has been developed with a special focus on applications that require the highest speed and accuracy at medium distance ranges with small size and very low power consumption
- Devices work on various objects including white, black and colored surfaces as well as reflective metallic surfaces

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Target Applications in Industry

- Industrial Sensing
- Presence Detection
- Movement – Speed/Direction
- Gesture Sensing in HMI
- Robotics - Collision Avoidance
- Camera Focus / Surveillance
- Alignment functions
- Level Check
- Parking Sensor

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Target Applications in Healthcare and Consumer Markets

- Breathing Monitor
- Patient Vehicles
- Gesture Sensing for HMI

- Service Robotics (Vacuum, Mowing)
- Drones (Collision avoidance, landing function)
- Logistics Robots

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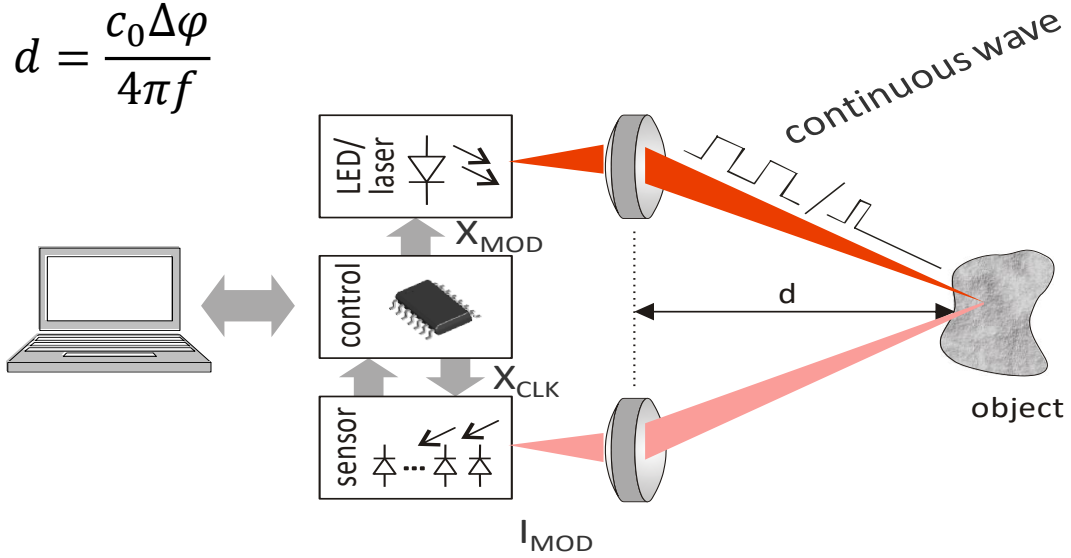
AFBR – S50 Platform: Principle of Operation

$$d = \frac{c_0 \Delta\varphi}{4\pi f}$$



- Correlating the phase Information of transmitted and received signals, enables the exact calculation of distances
- Combined with our high dynamic range detector technology, we are able to process signals even under the presence of high ambient light
- The technology has many advantages compared to pulse ranging and triangulation sensors

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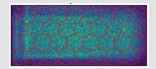
AFBR-S50 ToF Sensor Family

TOF Sensor:	AFBR-S50MV85G	AFBR-S50LV85D	AFBR-S50MV68B	AFBR-S50MV85I
TOF Sensor Evalkit	AFBR-S50MV85G-EK	AFBR-S50LV85D-EK	AFBR-S50MV68B-EK	AFBR-S50MV85I-EK
Max. Range (black)	Medium: 10m	Long: 30m	Medium: 10m	Med-Short: 5m
Laser Light Source:	850nm (IR)	850nm (IR)	680nm (red)	850nm (IR)
Res. / Pixel	1.55°x1.55°	1.55°x1.55°	1.55°x1.55°	1.55°x1.55°
Beam Divergence Tx: Measured Spot:	4°x4° 	< 2°x2° 	< 1°x1° 	13° x 6° 
Illuminated Pixels:	7-16 (32)	1-3 (32)	1 (32)	32
Field of View:	< 12.4°x6.2°	< 1.55°x3.1°	1.55°x1.55°	12.4°x6.2°
Weight:	0.76g	0.76g	0.76g	0.76g
Status	Production	Production	Production	Production

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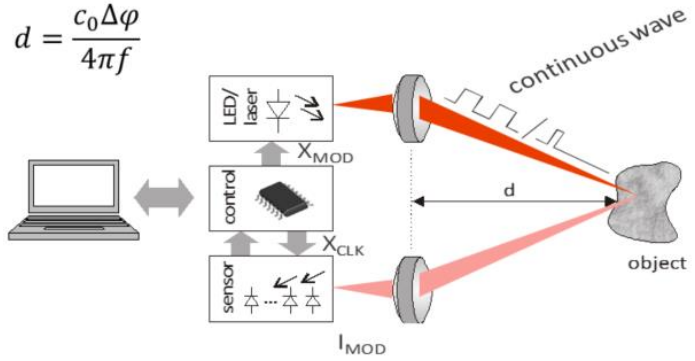
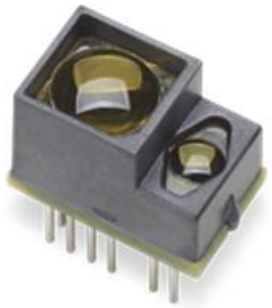
Broadcom TOF Sensor Platform AFBR-S50

Principle of operation: Indirect TOF

$$d = \frac{c_0 \Delta\varphi}{4\pi f}$$





AFBR-S50 Sensor Advantages
- Immune to ambient light and other optical signals
- Integrated Laser light source (850nm /680nm)
- High integration level
- Distance range 0,01 – 30m
- Accuracy better than1%
- Multi pixel option (1-32 pixels)
- Works well on all surface conditions
- Up to 3kHz Framerate
- Laser Class 1 (Eysesafe)

For more information:

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

Order:

https://www.avnet.com/wps/portal/ebv/products/new-products/npi/2018/broadcom-afbr-s50-family/

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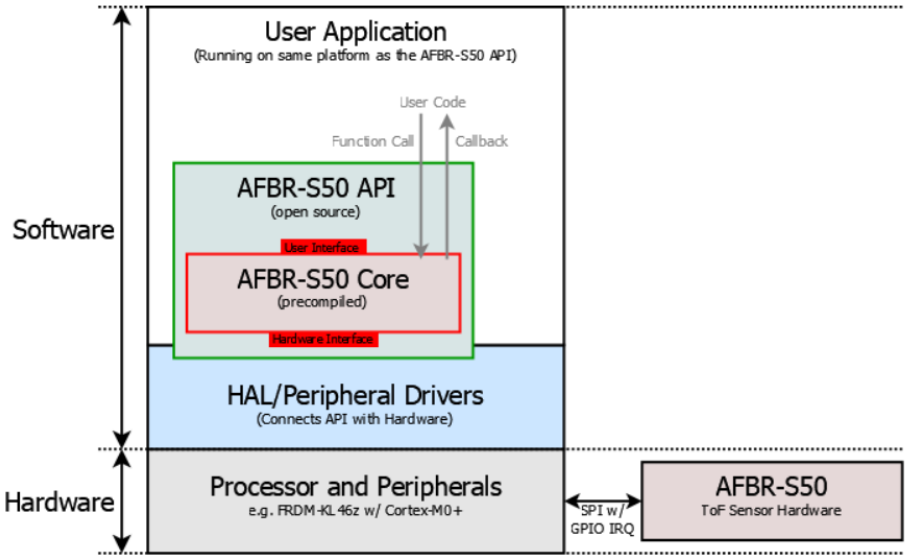
AFBR-S50 HW/SW Interface

- The functionality of the ToF Sensor is completely accessible through an **SPI** protocol from any microcontroller
- Configuration and measurement tasks are triggered by the external microcontroller using the ToF driver firmware
- The ToF driver firmware extracts both the distance and amplitude values of all used pixels on a per-frame basis
- Explorer software application from the SDK enables fast hands-on with the sensor (w/o coding) by providing a graphical data representation of distance & signal amplitudes
- Enhanced methodologies are available as plug-ins



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AFBR – S50 Platform – Sensor Parameters

Accessible Interface enables adjustmet of the following Parameters:

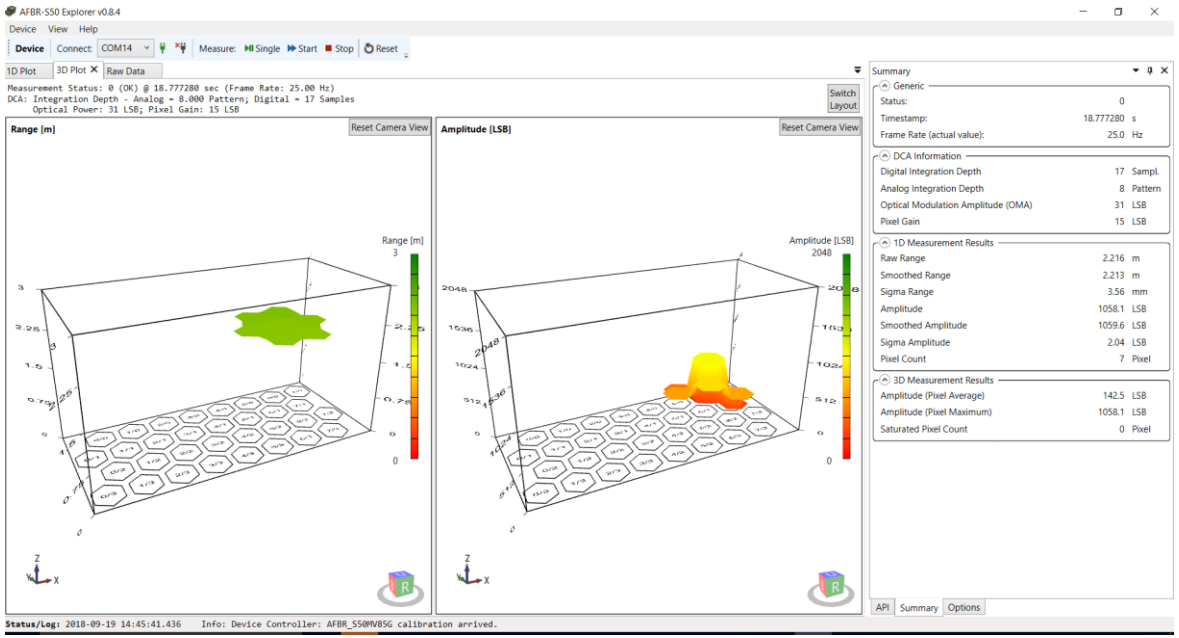
- Framerate
- Pixels
- Dynamic / Unambiguous Range

Sensor Results:

- Pixel based distance over time information (3/2D)
- Background light
- Amplitude (Signal quality, SNR)

Proactive Monitoring Function:

- Voltages
- Laser monitoring
- Temperature



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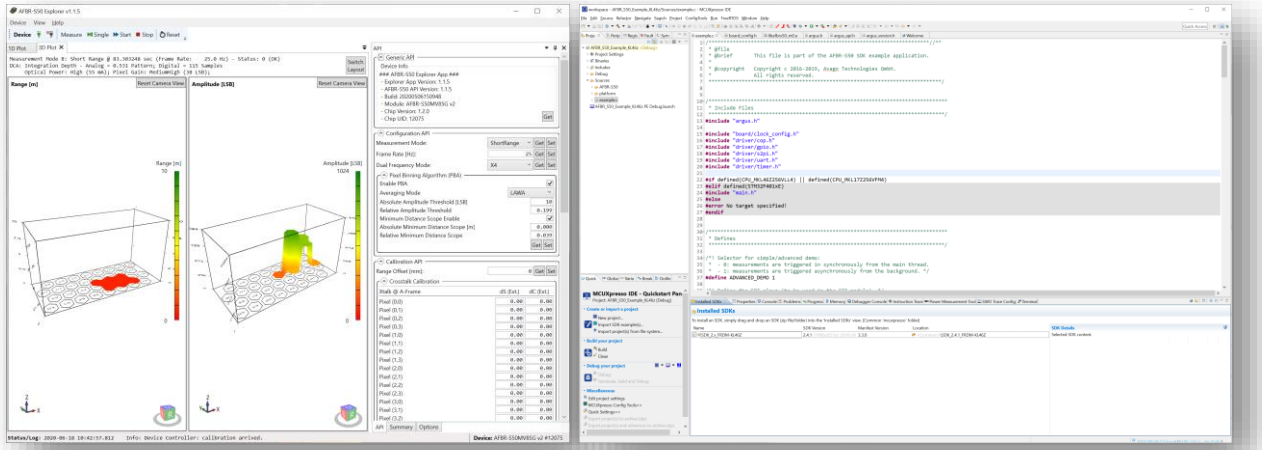
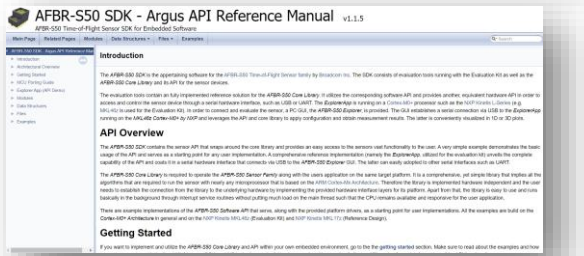
AFBR-S50 SDK

Development Platform for simple sensor integration in various applications





Features:

- Easy to install
- Explorer SW Graphical User Interface (GUI)
  - Fast hands-on with the sensor
  - Example representation of data with different plots
  - Data logger to record acquisitions
  - Fast overview of API capability
- Documentation of Software
  - Getting started guide
  - API Reference manual
  - Release Notes
- Precompiled libraries for ARM Cortex M0/+,1,3 & 4
- Example code to get started with code implementation

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AFBR – S50 Platform – Explorer GUI

Accessible Interface enables adjustment of the following Parameters:

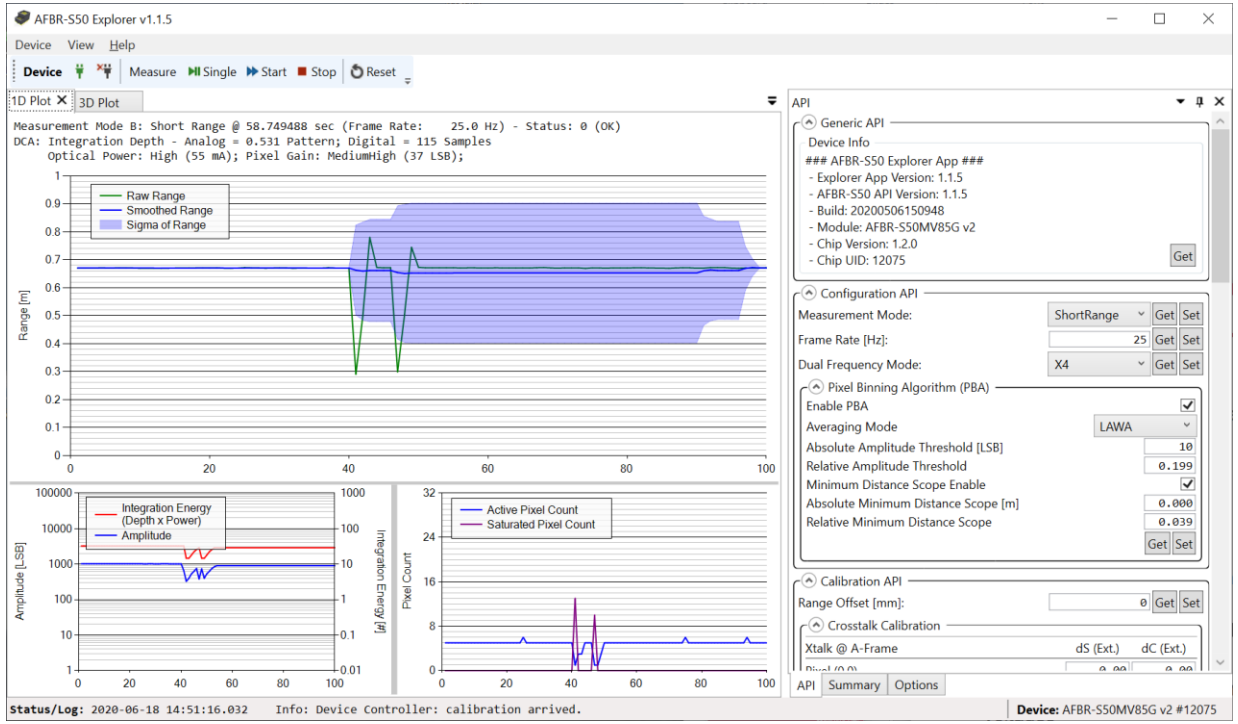
- Framerate
- Pixel binning
- Unambiguous Range / Dual Frequency Mode

Sensor Results:

- Binned distance over time information (1/3D)
- Integration Depth / Gain
- Saturated / Active Pixel Count
- Amplitude (Signal quality, SNR)

Accessible Monitoring Parameters:

- Voltages
- Laser monitoring
- Temperature
- Ambient light indicator



C# based GUI available for fast hands-on

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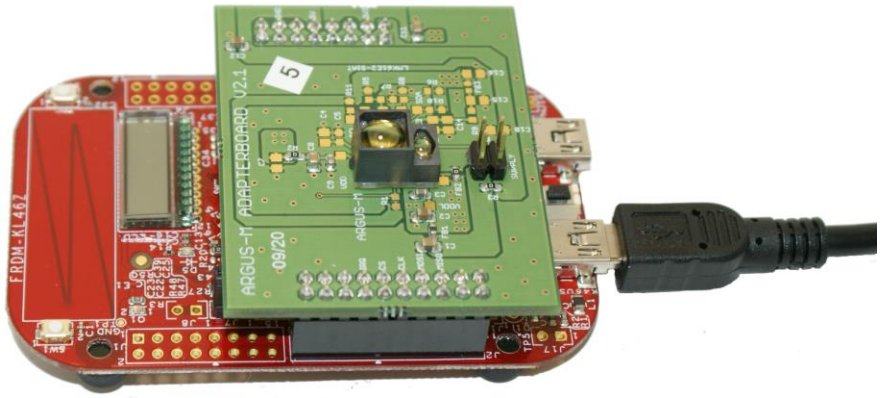
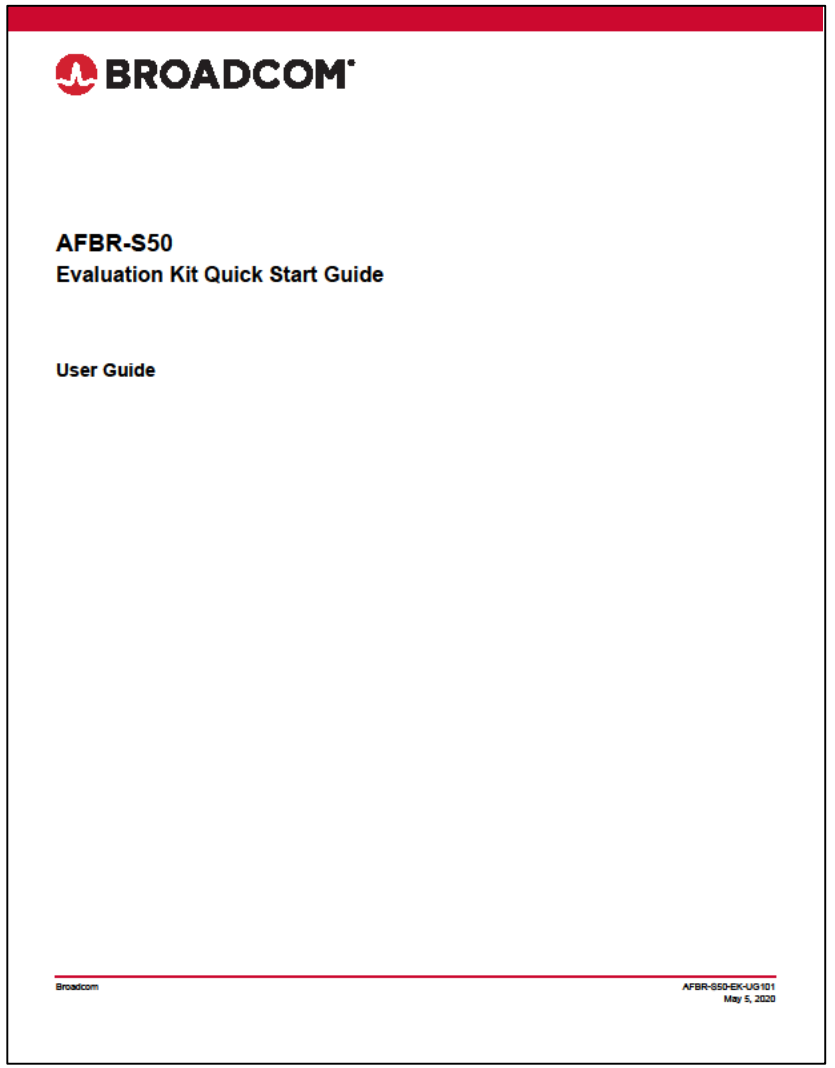
Evaluation Kits: AFBR-S50MV85G-EK/ AFBR-S50MV85I-EK

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AFBR-S50
Evaluation Kit Quick Start Guide

User Guide

Broadcom
AFBR-S50-EK-UG101
May 5, 2020

Evaluation kit Contains:

- ARM Cortex 0+ Board
- Adapter Board with either
  - AFBR-S50MV85G
  - AFBR-S50MV85I
- USB-Cable

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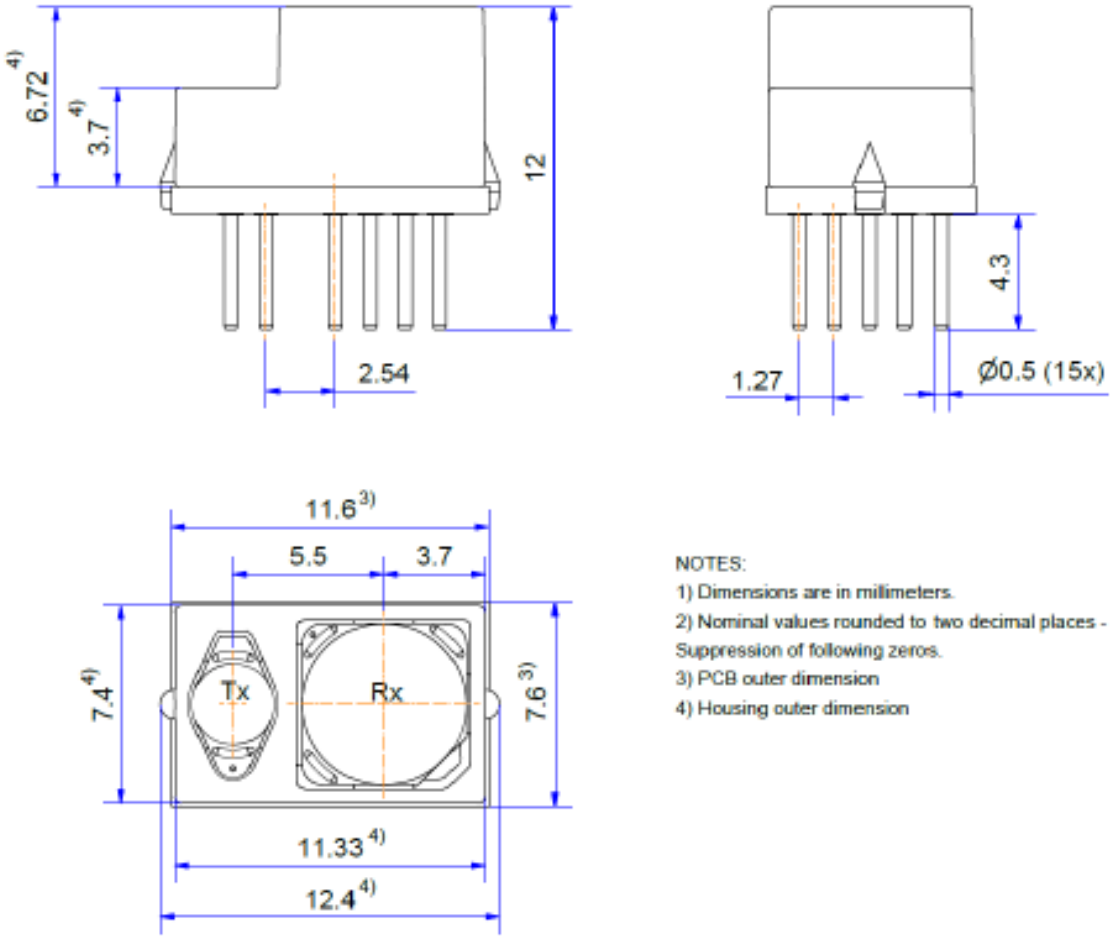
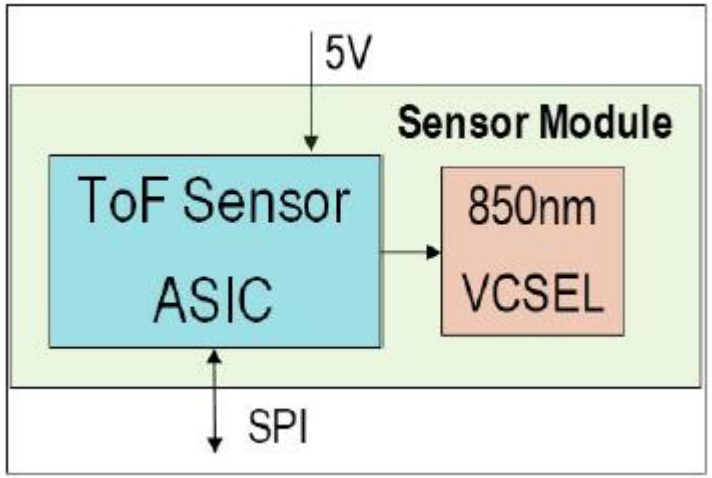
AFBR-S50
Mechanical Dimensions and Functional Block Diagram

Mechanical Dimensions

Figure 1: Module Side and Top View (Dimensions in mm)



NOTES:
1) Dimensions are in millimeters.
2) Nominal values rounded to two decimal places - Suppression of following zeros.
3) PCB outer dimension
4) Housing outer dimension



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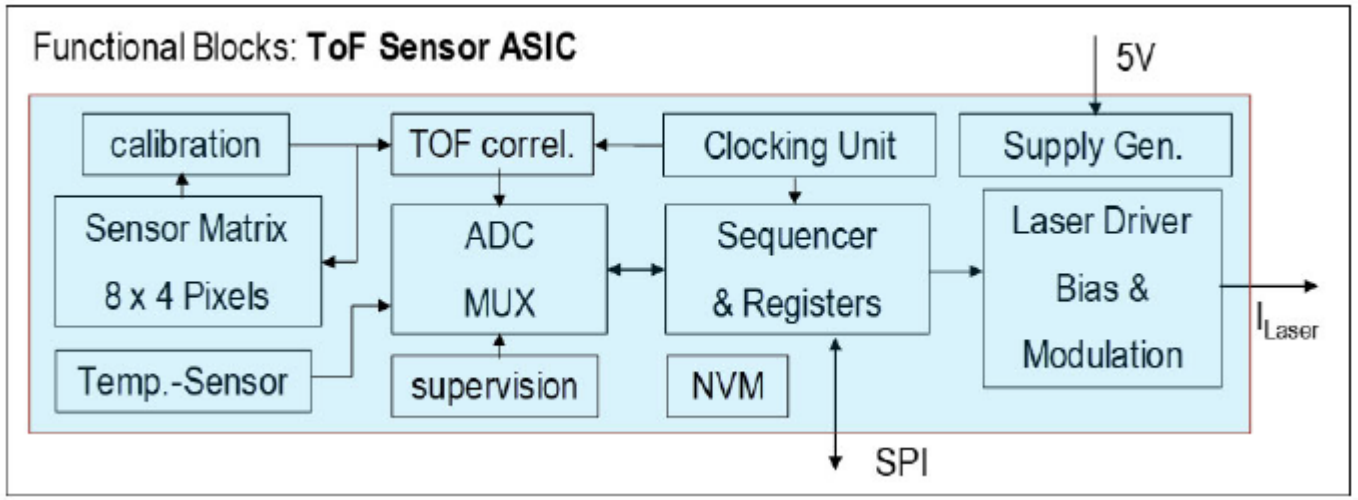
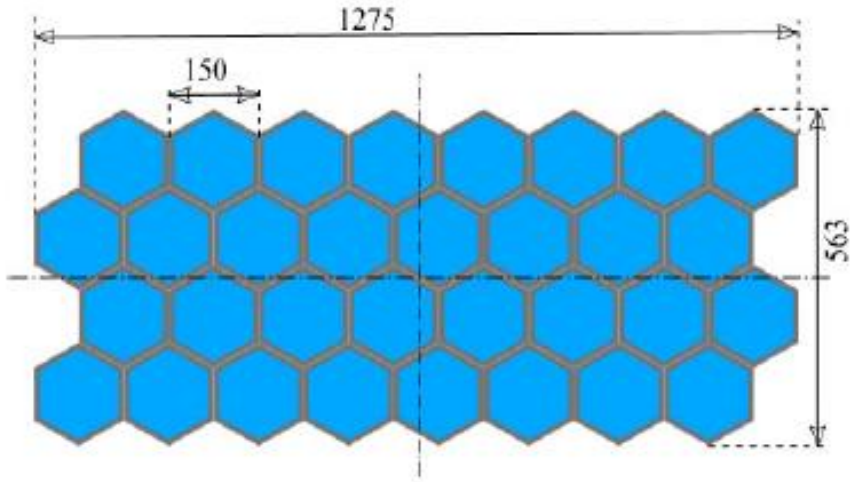
AFBR-S50MV85G – ToF Sensor Asic and Sensor Matrix



The ToF sensor ASIC includes:

- clock and supply voltage generation from a single supplied voltage
- analog and digital signal processing
- integrated laser driver



- ✓ 8x4 receiver Sensor Matrix with hexagonal structure
- ✓ Between 7 and 16 pixels will be illuminated depending on distance and reflectivity of the target object.

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Summary & References

Broadcom ToF Sensor Advantages

- **High Level of Integration**
  - Pixel Cluster and ToF correlation logic with 100% fillfactor
  - Analog-Digital conversion, digital-only host interface
  - Integrated Laser/LED Driver, temperature and voltage sensors and monitor Pixel
- **High speed frame rate and excellent ambient light suppression**
  - Measurement frame rate up to 3kHz
  - Ambient Light Suppression for optimum indoor and outdoor applications
- **High Flexibility**
  - Variable number of measurement phases, integration time and modulation frequencies
- **Low System integration complexity**
  - Each phase is measured autonomously, no real-time processing required
  - µC only needs to read out measurement data upon an interrupt once integration is finished

Additional customizaiton available – contact us for further information!

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Thank You


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