Presence and speed detection with dToF

Application Note

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Presence and speed detection with dToF

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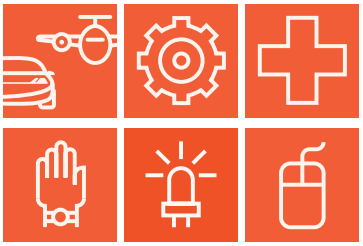

Valid for:
TMF8X0X, TMF882X

Abstract

This paper explores the potential of the TMF880X sensor family for detecting the presence and speed of objects or individuals in various environments.

Time-of-flight (ToF) sensors, using the principle of measuring the time taken by light to travel to an object and back, offer a reliable and accurate solution for presence detection applications. By emitting light pulses and measuring their reflection, ToF sensors provide high-resolution, real-time data on object proximity and position, making them highly suitable for applications such as automation, smart environments, security systems, and human-machine interaction.

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1 Introduction

dToF (direct Time-of-Flight)-based presence detection offers significant advantages over PIR (Passive Infrared) sensors, particularly in accuracy, functionality, and environmental adaptability. Unlike PIR, which relies on detecting movement through changes in infrared radiation, dToF measures the time taken for emitted light pulses to reflect off objects. This enables precise distance information and even speed and identification of direction of movements. This allows dToF to detect stationary occupants, eliminating PIR's limitation of requiring motion. While PIR may struggle with slow movements or broad temperature gradients, dToF maintains consistent performance across varied conditions, and enhances applications like smart security or automation by delivering detailed, real-time presence data.

For example the 1D ToF sensor TMF8806 perfectly covers the requirements for such a system. Its excellent immunity against dirt and sunlight, the low-power operation and ranging ability up to 10 meter matches all needs.

1.1 Ordering information

Ordering code	Description
TMF8806-1AM	Tape & reel (7″ reels) 500 pcs/reel
TMF8806-1A	Tape & reel (13″ reels) 5000 pcs/reel
TMF8806_EVM_DB_DEMO	TMF8806 ToF Evaluation Module
TMF8806_EVM_EB_SHIELD	TMF8806 Arduino shield board
TMF8801-1BM	Tape & reel (7″ reels) 500 pcs/reel
TMF8801-1B	Tape & reel (13″ reels) 5000 pcs/reel
TMF8801_EVM_DB_DEMO	TMF8801 ToF Evaluation Module

2 Target applications

Table 1: Presence detection typical applications

Target applications (Non-exclusive)		Functionality	Typical use cases
	Personal computing	Presence detection	Accurate sensing of objects or individuals to enable responsive automation
	Access Control & Surveillance	Speed detection	Precise measurement of object velocity for real-time monitoring and control
	Smart Appliances	Presence detection	Wake up of the user interface if a person is present
	Industrial Factory Automation	Presence detection	Safety for users
	Home & Building Automation	Presence detection	Key lock activation based on people presence. Energy saving lighting system

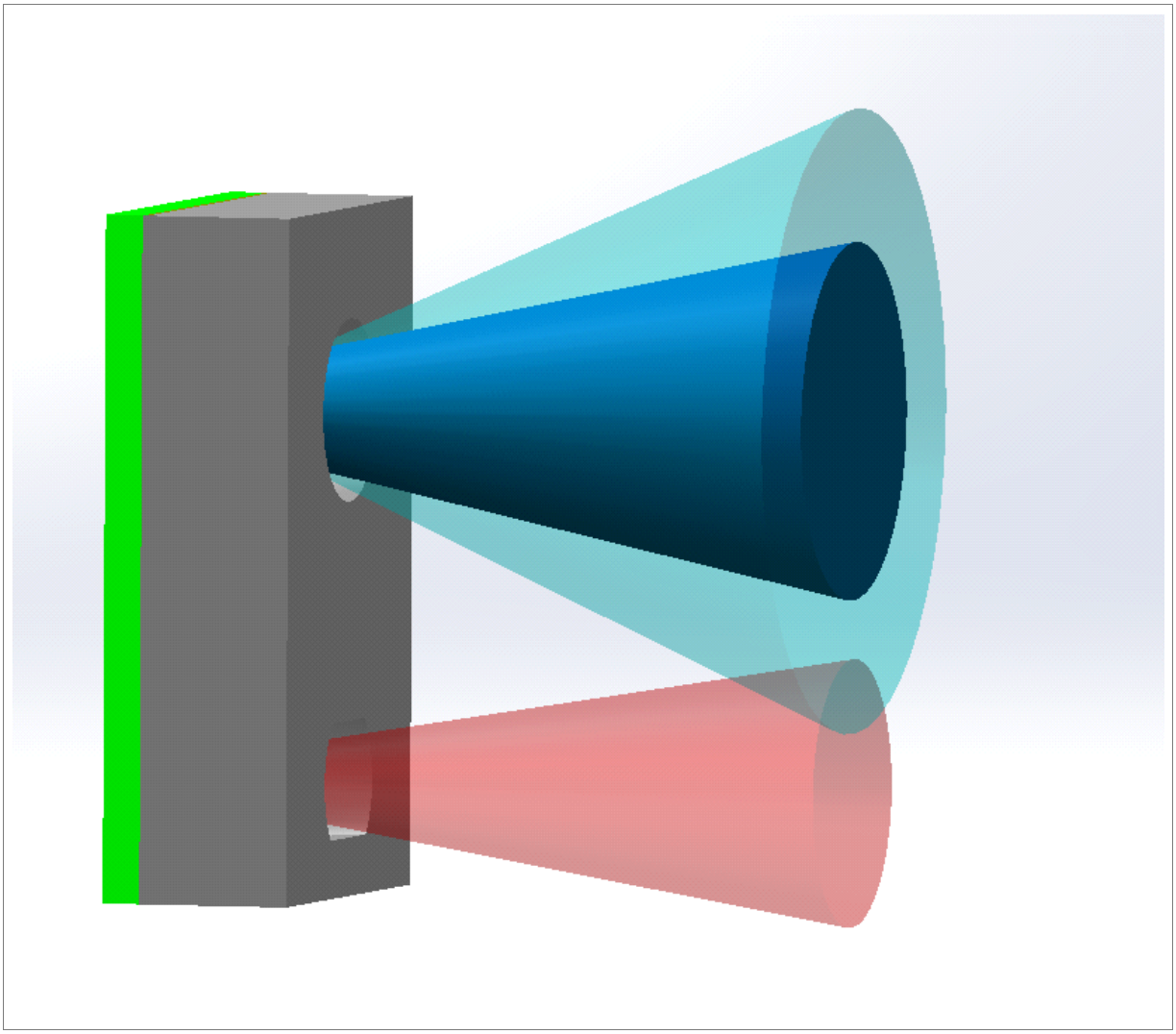
3 System description

The TMF880X is placed in the display bezel close to the camera system. On open lid it detects if an object is within one meter distance and triggers the face recognition system to identify the object.

The TMF8806, used in the example, has a typical FOV of 30° (dark blue cone below) and a FOI of 21° (red cone below). TMF8806 detects objects within the smaller of these values; therefore, TMF8806 detects objects within 21° field of view.

The 21° FOI (Field Of Illumination) monitors a circular shaped area with a diameter of 3.7cm in 10cm distance and a diameter of 37cm in 1m distance – a balanced compromise: The system avoids detecting nearby obstacles or the table while still covering a sufficiently large area to reliably sense a user's presence in further distance.

Figure 1: TMF880X placed in the display bezel



The system will work in most office light conditions even with dirt or smudge on the cover glass.

4 Presence detection demo for TMF880X

This section describes an existing presence detection demo which can be used as a good starting point for a presence recognition system. The used sensor for this demonstration is the TMF8801 and have the same sensor output data as the TMF8806.

4.1 Algorithm description

The presence detection demo of the TMF880X represents a low power triggering system for a user detection system. With a repetition rate of 30Hz it starts measurements and reports the distance to the closest object back to the sensor hub.

If the measured distance is within 20cm and 1m, the system checks if the object was moving within ±2cm for the last 10 seconds or not. Outside this range, the system reports a far object, regardless if moving or not.

Only a moving object within the distance range will trigger the face recognition system to start up and unlock the notebook on a successful user recognition.

A reported static distance is assess as an obstacle like a chair and not a user. This prevents continuous trigger of the face recognition system and saves a lot of power. The thresholds for moving objects and the valid distance range can be easily adjusted on the sensor hub.

If no user or a far object is detected for a defined time the operating system will be locked automatically.

The demo uses a low pass filter to detect if an objects moves. It weights the actual measurement with 30% and adds 70% of the previous weighted result to it.

Equation 1:

$$\Delta\mathrm{dist}_{\mathrm{LP}} = \Delta\mathrm{dist}_{\mathrm{LP}_1} * 0.7 + (\mathrm{dist} - \mathrm{dist}_{_1}) * 0.3$$

In other words, $\Delta dist_{LP}$ is a measure of the speed of the detected object and the sign defines the moving direction.

The distance measurement uses a median filter of last 7 measurements – this smoothens the distance and rejects any outliers.

Equation 2:

$$\mathrm{dist}_{\mathrm{med}} = \mathrm{med}(\mathrm{dist}, \mathrm{dist}_{_1}, \mathrm{dist}_{_2}, \mathrm{dist}_{_3}, \mathrm{dist}_{_4}, \mathrm{dist}_{_5}, \mathrm{dist}_{_6})$$

As long as the object is within $dist_{med}$ > 20cm and $dist_{med}$ < 100cm and $\Delta dist_{LP}$ < 3mm the minimum and maximum values of $dist_{med}$ are stored and the delta of both have to stay within 2cm. If these boundaries are fulfilled for more than 10 seconds the algorithm will report a static object otherwise minimum and maximum values will reset.

4.2 Setting up the EVM

Referring documents:

See document “UG000416 – TMF8x01 EVM User Guide” Section 2.

4.3 Installing the EVM graphical user interface

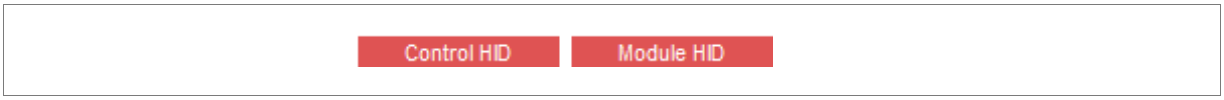
Launch the Windows installer and choose the desired installation options. The EVM graphical user interface executable is titled ToF_1D_DEMO.exe.

ams OSRAM / tmf8801_8805_software_releases

4.4 Graphical user interface (GUI)

If no TMF8801–EVM is connected to the PC the 2 indicators on bottom are red and a test mode is started.

Figure 2: Connection status (Test mode) of TMF8801–EVM to the PC

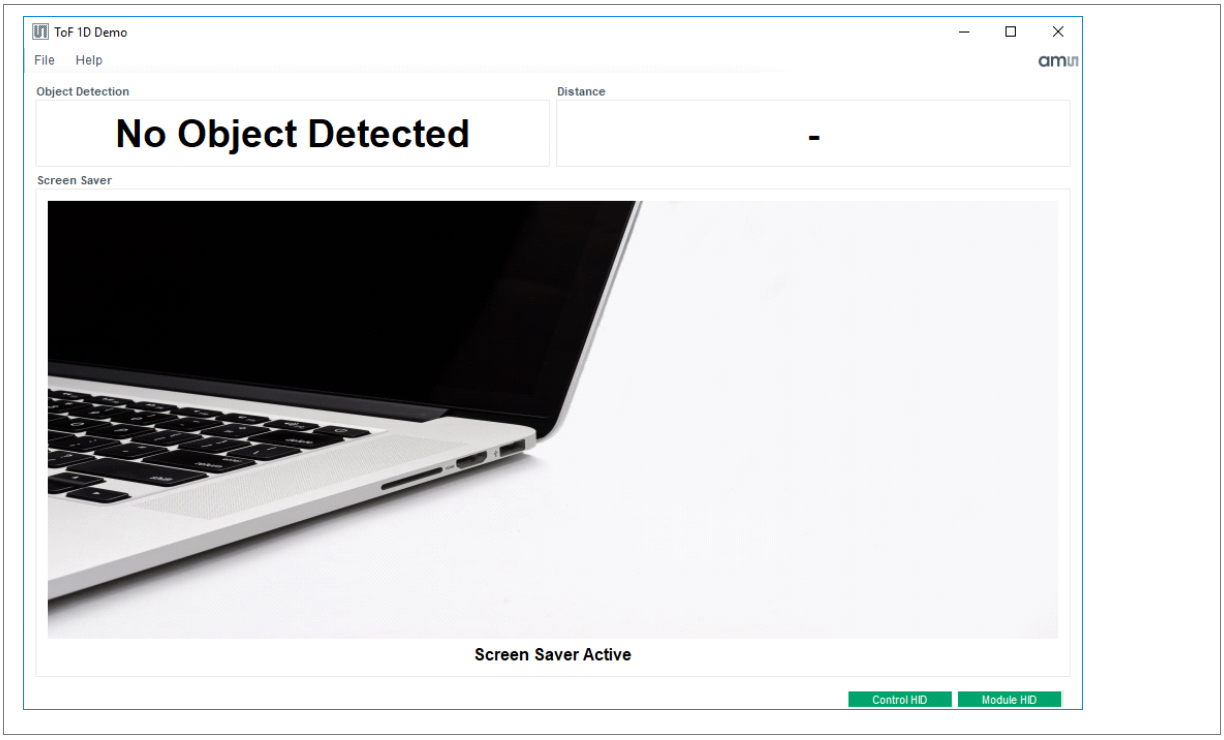


After connecting the TMF8801-EVM both indicators will turn green and the demo starts operating.

Figure 3: Connection status (Demo) of TMF8801–EVM to the PC

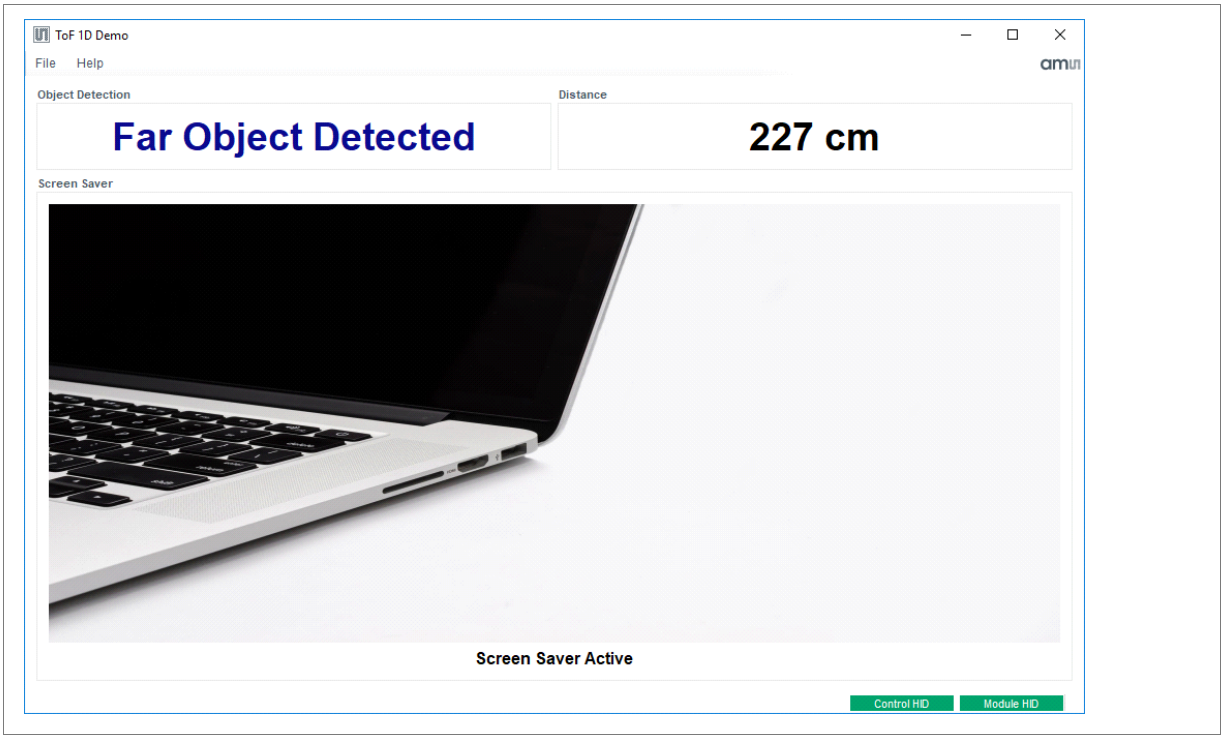
If no object can be detected within the maximum range, the GUI reports “No Object Detected” and doesn’t show and distance information.

Figure 4: GUI status (“No Object Detected”)



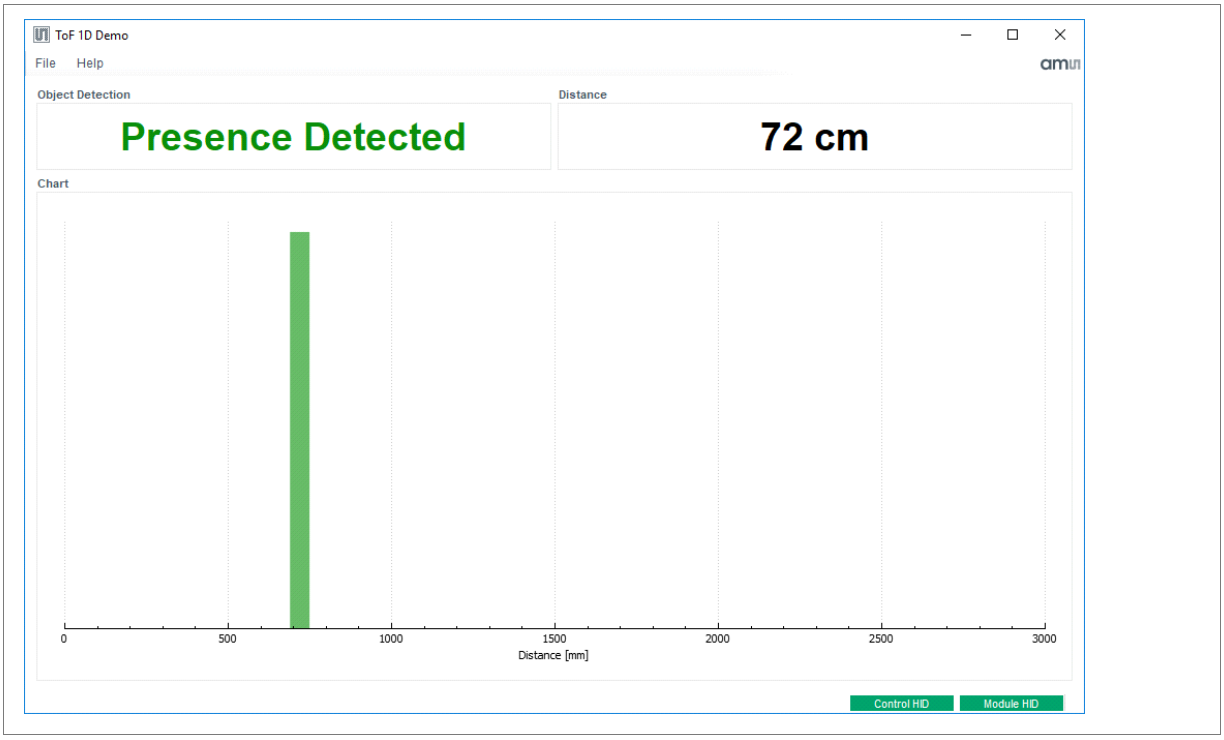
If an object can be detected but it is outside the user presence detection limit of 1m, the GUI reports “Far Object Detected” and displays and distance to this object. The screen saver remains active.

Figure 5: GUI status (“Far Object Detected”)



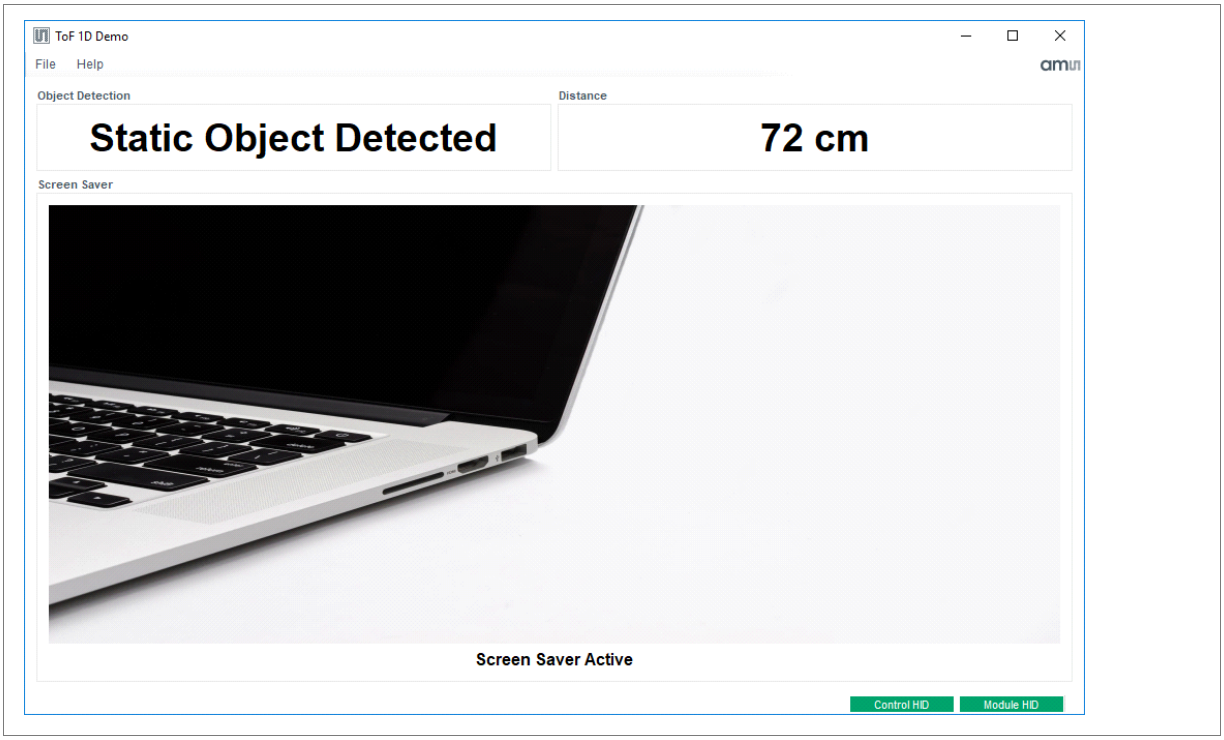
When the object is within 20cm and 1m distance and moving the presence is detected and the screen saver disappears. The bar chart shows the distance to the object and the height of the bar represents the confidence level of the measurement.

Figure 6: Bar chart



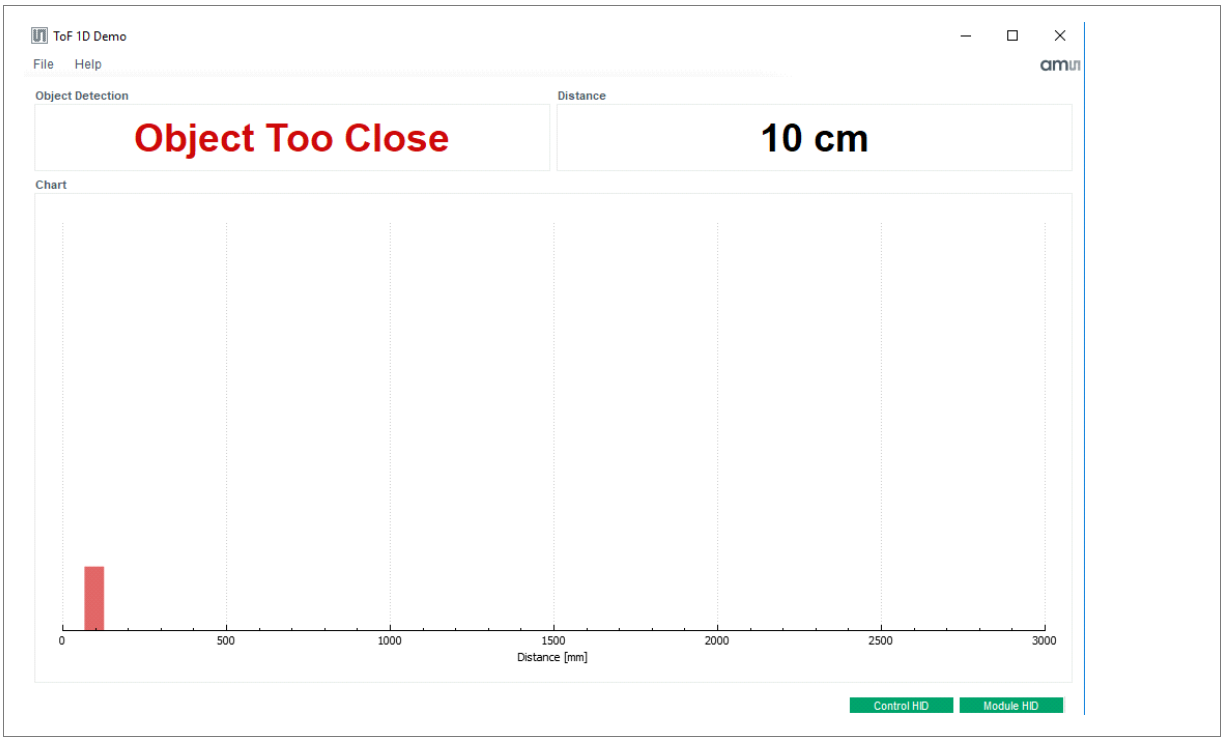
If the object is within 20cm and 1m but not moving the status will change to “Static Object Detected” but the distance will still be shown. The screen saver gets active.

Figure 7: GUI status (“Static Object Detected”)



If the distance of the object is closer than 20cm the bar will turn red and screen locks after 10 seconds.

Figure 8: Bar chart



5 Revision information

Changes to current revision v1-00	Page
Initial production version	

- Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
- Correction of typographical errors is not explicitly mentioned.

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