



# Smoke Detection Solutions

## Frequently Asked Questions



### Certification and Regulation Standards

#### Q ADPD188BI general performance standards

The ADPD188BI is engineered to meet new UL 217/UL 268 requirements as well as EN 54/EN 14604 specifications. However, based on the performance and capability of the ADPD188BI, there is a high level of confidence that it will pass other international regulations (ISO 7240).

#### Q Does the ADPD188BI pass the new UL 217 cooking nuisance test?

In UL testing, using the ADPD188BI along with the EVAL-CHAMBER smoke chamber, we have shown that an alarm threshold can be set between the hamburger smoke and the flaming polyurethane smoke with a 10%

margin that enables passing the UL 268 and UL 217 cooking nuisance tests.

#### Q How do you differentiate a nuisance source from a smoke source with a similar blue to IR ratio, similar to smoldering polyurethane and steam?

These events tend to happen on very different time scales. A smoldering plastic event tends to occur over tens of minutes to hours, whereas a steam event tends to occur very rapidly.



### Performance

#### Q Do these sensors need to be calibrated?

No user calibration is required with these sensors because ADI precalibrates the devices at room temperature using our high accuracy test solution. The gain and offset calibration coefficients of both LEDs are saved in ADPD188BI's eFUSE registers, ensuring the consistency of ADPD188BI's infrared and blue LEDs. Please refer to AN-2033 for details on reading eFUSE registers and applying calibration coefficients. The typical response curves for blue and IR LEDs over temperature are provided in ADPD188BI's data sheet (typical performance characteristics). This information can be used to correct for variation due to temperature.

#### Q Why do we use dual wavelengths?

The scattering cross section is a function of wavelength, particle

size, and angle. By using two wavelengths and the same angle, you can estimate particle size, which allows you to better differentiate between different types of smoke or nuisance sources. In some cases, you can also increase the detection margin (one smoke type responds better to IR while another responds better to blue).

#### Q How does dust affect the performance of the sensor?

Dust buildup inside a smoke chamber can be an issue in smoke detectors. A chamber designed for a backscatter system tends to be more prone to this issue. The surface of the chamber facing the ADPD188BI is designed to reflect away from the part. If dust settles on this surface, it will scatter some amount of the light back to the part, shifting the dc level. As long as the total dc level remains similar to or less than the alarm threshold levels, the effects of dust can be removed with a long-term averaging filter.



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## Principle of Operation

### Q Is forward scattering more efficient than the ADPD188BI scattering method?

The forward scattering event itself is more efficient. However, more light is lost due to the larger distances involved in a forward scattering system. The net effect is that the total efficiency is similar.

### Q Why does the dc background level need to be smaller or similar to the alarm threshold level?

A larger background level will magnify the effects of any changes in the system, such as vibration and temperature. If the background level is significantly larger than the alarm threshold level, these other effects

can cause significant shifts in the performance of the device or require additional algorithmic work.

### Q How are smoke response results presented?

The smoke response for the blue and IR channels of the ADPD188BI is demonstrated by the power transfer ratio (PTR) in units of nW of optical power returned to the photodiode per mW of optical power emitted by the LED. Presenting results with PTR allows a meaningful comparison of different types of smoke. The conversion from PTR to actual code counts expected from the system is a function of the specific AFE settings, including gain, number of pulses, and LED current.



## Chamber and Optical Design

### Q Do we need a new smoke chamber design?

Yes. The smoke chamber needs to be designed such that the dc level is similar to or less than the alarm threshold levels. An ADPD188BI-based system is more sensitive to material directly above the sensor (because of the orientation of the optics) than a forward scatter system and, in almost all designs, a dc level will be present. This dc level can also be used in a full self-test of the alarm and to assist in observing the long-term drift of the device. ADI has designed a new patented smoke chamber that is optimized to work with the ADPD188BI. There are two evaluation models available: EVAL-CHAMBER (two pieces) and EVAL-CHAMBER-10 (10 pieces). The production version is the Accumold 28800X and is available from Accumold and Arrow. Alternatively, please contact ADI if interested in licensing this design.

### Q Can we build a smoke detector without a chamber?

Yes, but there are two major challenges in building a chamberless system: ambient light and separating proximity from smoke events. The ADPD188BI has excellent ambient light rejection, and designs have been demonstrated that can pass the EN dazzle test. And proximity events (a person walking underneath the detector) can be separated from a smoke event by looking at the ratio change in the two colors.

### Q What size is the ADI chamber?

The chamber is 30 mm × 36 mm × 11.4 mm.

### Q How can I manage for the ingress of dust and bugs on the solution?

A high-pass filter can be applied to manage the issue and remove the background noise from the chamber. To keep the chamber clear of bugs and other obstructions, a bug net or mesh can be added.



## Quality and Reliability

### Q What operational conditions/limitations have been tested for the CN-0537 reference design?

The CN-0537 reference design is tested against what's specified in UL 217 for temperature and humidity.

Lifetime is not a test that was run, as the estimated lifetime will change based on how customers plan to use their device in their application.

Assuming nominal operation at 38°C, our burn-in data shows that LED light degradation after long-term use is <20%. UL 217 specifies that light degradation must be <50%. The ADPD188BI was subjected to multiple burn-in stresses for >1000 hours with higher than typical settings as per the data sheet. This provided burn-in data, which is used to calculate acceleration factors, on the photodiode, LED, and ASIC subcomponents. These acceleration factors, when applied for a 38°C use case, show a predicted lifetime up to 20 years with normal operation.

the environment around the ADPD188BI module. The EVAL-CHAMBER smoke chamber is attached to the EVAL-ADPD188BIZ-S2 evaluation board with rivets or self-tapping screws. Figure 1 (page 4) shows the smoke chamber attached to the evaluation board using rivets.

For optimal smoke detection, ensure that the chamber is perfectly centered over the ADPD188BI sensor. This is achieved by placing the chamber over the marked white circle on the eval board.

To limit interference, ensure that the digital lines are kept away from the power supply, as this will decrease power interruption. Additionally, when utilizing external inputs on the eval board, keep connections away from the digital components for best practices. Follow general best practices for grounding and decoupling capacitors.

### Q What are the best practices for layout?

The EVAL-ADPD188BIZ-S2 evaluation board is designed to be used with the EVAL-CHAMBER smoke chamber. The smoke chamber helps control

### Q What is the MTTF?

MTTF refers to mean time to failure, which is the mean time it takes for a first failure to occur under specified operating conditions. It is calculated by dividing the total number of device operating hours by the number of failures. Details of the ADPD188BI MTTF can be obtained at [analog.com/reliabilitydata](http://analog.com/reliabilitydata).



## Algorithm and Software

### Q Does ADI provide software assistance or algorithms?

Yes. ADI has a complete smoke detection reference design (CN-0537) plus software and algorithm that is tested to meet the UL 217 8<sup>th</sup> edition smoke/fire detection standards. To address the needs of different customers, a number of solution offerings are available, which are summarized in the table below.

### Q What are the processing recommendations or requirements?

At a minimum, the microcontroller should be a 32-bit Arm® Cortex®-M0 (or

equivalent) with 128 kB of Flash and 16 kB SRAM, and have either an SPI or I<sup>2</sup>C peripheral.

### Q Does the CN-0537 require temperature compensation?

The ADPD188BI smoke sensor requires temperature compensation. The CN-0537 has an on-board temperature sensor inside the chamber to measure the temperature, and the software compensates for that.

Solution Options	Description	Includes
<b>Hardware</b> EVAL-CN0537-ARDZ EVAL-ADICUP3029	Smoke detector reference design hardware for prototyping and solution evaluation. A tested and verified UL 217 smoke detection algorithm is embedded as part of the installer for evaluation.	<b>Hardware</b> <ul style="list-style-type: none"> <li>▶ Smoke detector (CN-0537) reference design</li> <li>▶ Microcontroller development board (ADICUP3029)</li> </ul> <b>Software</b> <ul style="list-style-type: none"> <li>▶ UL 217 embedded SW executable (.hex)</li> <li>▶ ADPD188BI no-OS driver</li> </ul> <b>Documentation</b> <ul style="list-style-type: none"> <li>▶ CN-0537 circuit note</li> <li>▶ CN-0537 hardware user guide</li> <li>▶ Tested and verified UL 217 test result</li> </ul>
<b>Data</b> EVAL-CN0537-DATA	The CN-0537 source code (excluding the detection algorithm) provides an extensive smoke dataset taken at UL 217 certified facilities for those who wish to develop their own algorithm.	<b>Data</b> <ul style="list-style-type: none"> <li>▶ UL 217 test datasets files</li> </ul> <b>Software</b> <ul style="list-style-type: none"> <li>▶ CN-0537 source code (excl. detection algorithm)</li> </ul> <b>Documentation</b> <ul style="list-style-type: none"> <li>▶ UL 217 test datasets user guide</li> </ul>
<b>Algorithm</b> EVAL-CN0537-ALGO	<p>The algorithm (EVAL-CN0537-ALGO) package includes everything in the data package and a UL certified smoke detection algorithm with associated algorithm project files.</p> <p>This includes the full source code and a UL 217 8<sup>th</sup> edition tested and verified algorithm, associated project files, CN-0537 source code, and 1000+ sample fire/smoke datasets to accelerate system development.</p>	<b>Software</b> <ul style="list-style-type: none"> <li>▶ CN-0537 source code including UL 217 8<sup>th</sup> ed. detection algorithm (.c)</li> <li>▶ MATLAB® and Python UL 217 algorithm projects</li> </ul> <b>Data</b> <ul style="list-style-type: none"> <li>▶ UL 217 test datasets files</li> </ul> <b>Documentation</b> <ul style="list-style-type: none"> <li>▶ UL 217 algorithm documentation</li> <li>▶ UL 217 test datasets user guide</li> <li>▶ MATLAB/Python user guide</li> </ul> <b>Support</b> <ul style="list-style-type: none"> <li>▶ 10 hours of phone support</li> </ul>

## Additional Design Resources

### Q What additional evaluation resources are available?

EVAL-ADSMOKEKITZ is a comprehensive out-of-the-box smoke evaluation kit for high accuracy, integrated smoke detection monitoring. It provides users with all the necessary components to get up and running quickly with designing their custom smoke detection product, including the WaveTool graphical user interface (GUI).

### Q Are samples available?

An evaluation board is included in the EVAL-ADSMOKEKITZ Smoke Evaluation Kit. The board (model EVAL-ADPD188BIZ-S2) is available for purchase from the ADPD188BI product page at [analog.com/eval-adpd188biz-s2](https://analog.com/eval-adpd188biz-s2).

Samples are also available at: [analog.com/samples\\_purchase](https://analog.com/samples_purchase).

### Q What other resources are available?

For the latest list of available resources, see the Smoke Detection and ADPD188BI pages at [analog.com/smokedetection](https://analog.com/smokedetection) and [analog.com/adpd188bi](https://analog.com/adpd188bi).

### Q Other questions/feedback

ADI values feedback on our smoke sensing solutions. Please send questions or feedback to ADI via our online community at [ez.analog.com/optical\\_sensing](https://ez.analog.com/optical_sensing).

## Kit Components

**EVAL-ADPD188BIZ-S2:** The ADPD188BI evaluation board provides users with a simple means of evaluating the ADPD188BI optical sensor module. The EVAL-ADPD188BIZ-S2 is powered by the EVAL-ADPUCZ microcontroller board.

**EVAL-CHAMBER:** ADI designed smoke chamber (two pieces included) optimized for the ADPD188BI (see Figure 1).

**EVAL-ADPUCZ:** A microcontroller board used to support the ADI EVAL-ADPD188BIZ-S2.

**WaveTool GUI:** The WaveTool graphic user interface (GUI) provides users of the EVAL-ADSMOKEKITZ Smoke Evaluation Kit with both low level and high level configurability, real-time frequency, time-domain analysis, and user datagram protocol (UDP) transfer capability.



Figure 1. Evaluation board attached to chamber, top view.