Application Brief

Streamlining Smoke Detector Designs With Highly Integrated MSPM0 MCUs

TEXAS INSTRUMENTS

It is important to design reliable and accurate smoke detectors for life safety. There are two methods of smoke detection – photoelectric and ionization detection. Photoelectric detectors use LEDs and photodiodes to detect the presence of smoke. Ionization detectors use a radiation source for smoke detection. Photoelectric detection responds better to a smoldering fire compared to ionization detection, which respond better to a flaming fire. This application brief shows how to design a dual-ray photoelectric detector to improve detection on both types of fires using TI's MSPM0 portfolio of Arm® Cortex®-M0+ microcontrollers (MCUs).

In smoke detection circuits (see Figure 1), photoelectric detectors can use one or multiple LEDS. A microcontroller measures the photodiode current when the LEDs are turned off, and another when the LEDs are turned on. When smoke is not present in the chamber, there is little variance between the two measurements. When smoke is present, the LED light is diffracted throughout the chamber causing the photodiode to detect more light, which increases the current output and can be interpreted as smoke detection. Then, the photodiode current is converted into voltage by a transimpedance amplifier (TIA). The voltage is fed through a gain stage to allow proper sampling by an analog-to-digital converter (ADC). Using multiple LEDs provides the benefits of leveraging different wavelengths (such an IR and blue LEDs) to improve the detection of different types of smoke and rejection of false detections.
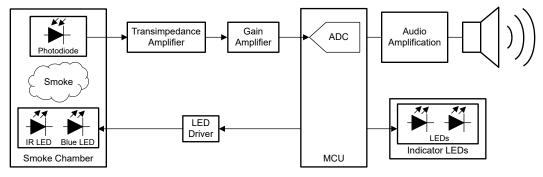

Figure 1. Smoke Detector Block Diagram

What can MSPM0 do in smoke detector applications?

The high level of analog integration in the MSPM0 portfolio helps optimize board space while lowering overall system costs. The MSPM0L134x MCUs can be used to design a dual-ray smoke detector by integrating the following analog peripherals: a zero-drift operational amplifier (OPA), a transimpedance amplifier with integrated programmable gain stage up to 32x, and an 8-bit reference DAC all at a low cost.

MSPM0L134x microcontrollers offer many key features such as:

• 2 OPAs (TIA and zero-drift OPA) with 10-pA input bias current
• High-speed comparator with an 8-bit reference DAC
• 1-μA standby current to eliminate system current consumption
• Fast clock wake-up times: <2 μs (from 50-μA stop) or <4.5 μs (from 1-μA standby)
• On-chip temperature sensor that can be used for temperature compensation of LED current strength and photodiode temperature drift
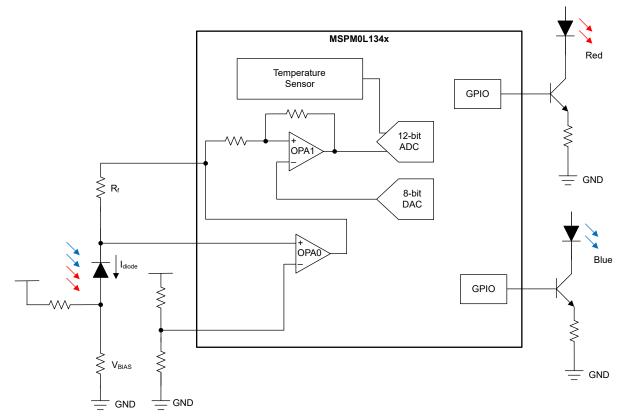
Figure 2. MSPM0 Solution for Smoke Detector

Figure 2 shows the dual ray smoke detector design using an MSPM0L134x MCU. The two OPAs are used for photodiode signal conditioning and the GPIOs are used for LED biasing. The TIA converts the photodiode current into voltage. The voltage is then fed into OPA1 where the amplified signal is fed to the internal 12-bit ADC for sampling. These on-chip analog peripherals are designed for flexibility and easy configuration.

For commercial smoke detectors, a simile communication interface can be used for the panel to be able to talk to individual detectors installed on a loop. The MSPM0 MCU can be used to decode this data respond back to the system. In residential smoke detectors, a piezo sounder is typically used to general alarm tones. The MSPM0 MCU can be used to interface to this using an H-bridge drive in order to output not only the alarm tone but also more complex audio waveforms like voice playback as well.

Conclusion

MSPM0 MCUs leverage TI's comprehensive analog integration to strengthen performance, lower cost, and create a reliable solution for smoke detectors. This MSPM0 portfolio offers pin-to-pin compatible packages, various memory variants, and diverse peripherals to help meet the system requirements to accelerate design to market. To begin, use the MSPM0L1306 LaunchPad development kit to develop and configure your designs for the many applications that a simple MCU can enable.

- MSPM0 overview page
- MSPM0 Academy

IMPORTANT NOTICE AND DISCLAIMER