A Low-Power Optical Smoke Detector

Associated Part Family: MC68HC908QT4
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Summary
In this project, the MC68HC908 is used as the core processor for the construction of a low-power optical smoke detector. By using infra-red LED and receivers, this project enables the detector to 'see' the presence of smoke particles in the air, thus enable us to trigger a signal to any standard commercial fire monitoring panel such that an alarm can be sound or other recovery actions can be taken. This project makes full use of the low power modes of the MC68HC908 such that the detector is operational at under 0.2mA.

Introduction

Traditionally, commercial smoke detectors were built using a small amount radioactive material to form an ionization chamber. Smoke entering this chamber would create a charge between two electrodes that are placed in the chamber causing a current to flow across the electrodes.

The use of the ionization chamber for smoke detection is both power and cost effective, but it is at the expense of possible risk to the user as radioactive materials are involved. Furthermore, there is a life time to these detectors as over time the radioactive materials lose some of their properties, causing the smoke detector to be ineffective. Lastly, the disposal of the used smoke detectors would also pose a potential hazard if not taken care of properly.

With the disadvantages of the ionization smoke detector, the photoelectric sensing or optical smoke detectors are introduced. These detectors make use of infra-red beams to detect the presence of smoke particles by measuring the deflection of IR rays using IR receivers.

The approach of using optical smoke detectors would remove the need for a hazardous radioactive material; however, more power would be consumed to drive the IR transmitters (usually IR LEDs). This could be overcome by the use of current pumps and the power saving modes of the components.

In this project, we would make full use of the low power mode, namely the STOP mode, of the MC68HC908QT4 to provide for a low power optical smoke detector. In a nutshell, the features of the microcontroller that would be utilized include the following:

- STOP Low Power Mode
- Auto Wakeup Module
- 1 x 8bit ADC
- 3 x I/O port

Overview of the smoke detection application

Figure 1 shows the general schematic diagram for the overall general smoke detection application. This schematic is also used in the general commercial implementation of smoke detectors in most buildings.

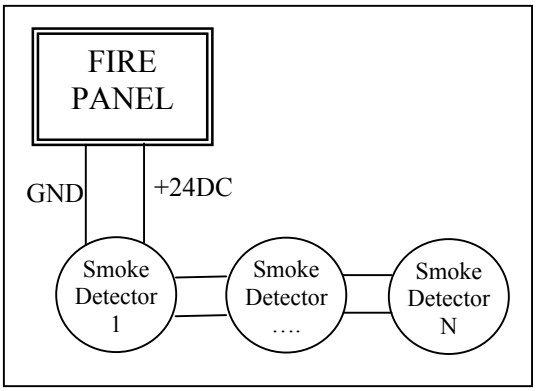


Figure 1: A typical smoke detector to fire panel connection

From Figure 1, the fire panel supplies a +24DC voltage source to the smoke detectors that are connected in parallel with each other. A typical fire panel is shown in picture 1, and this fire panel would be use to test the functionality of our smoke detector.

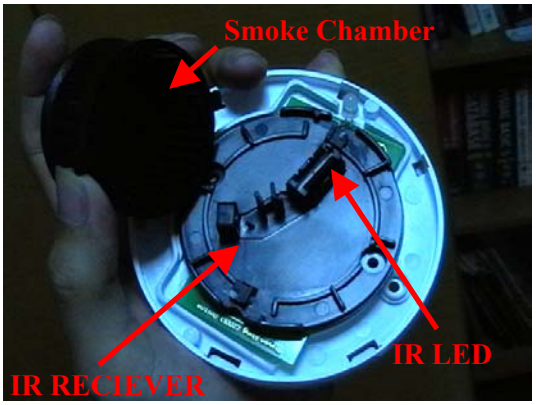
Typically, an alarm signal is sent by the smoke detectors to the Fire Panel through the use of the same voltage supply lines (or called channels or zones. One fire panel may have multiple channels). This is done through current monitoring carried out by the fire panel. In most instances, a fire signal is detected when the channel sources a current of more than a stated value, typically about 5mA. Thus, when a smoke detector detects a possible fire, it would sink more than 5mA such that the fire panel would be informed of the hazard. The use of current monitoring also limits the number of smoke detectors that can be linked with each channel on the fire panel, without causing a false alarm. The smoke detector that is designed in this project sinks only about 0.150uA during normal operations and sinks 130mA on alarm, thus it is logically possible to connect up to 37 smoke detectors to each channel.

Picture 1: An example of a commercial fire panel

Overview of the Smoke Detector Hardware/Circuitry

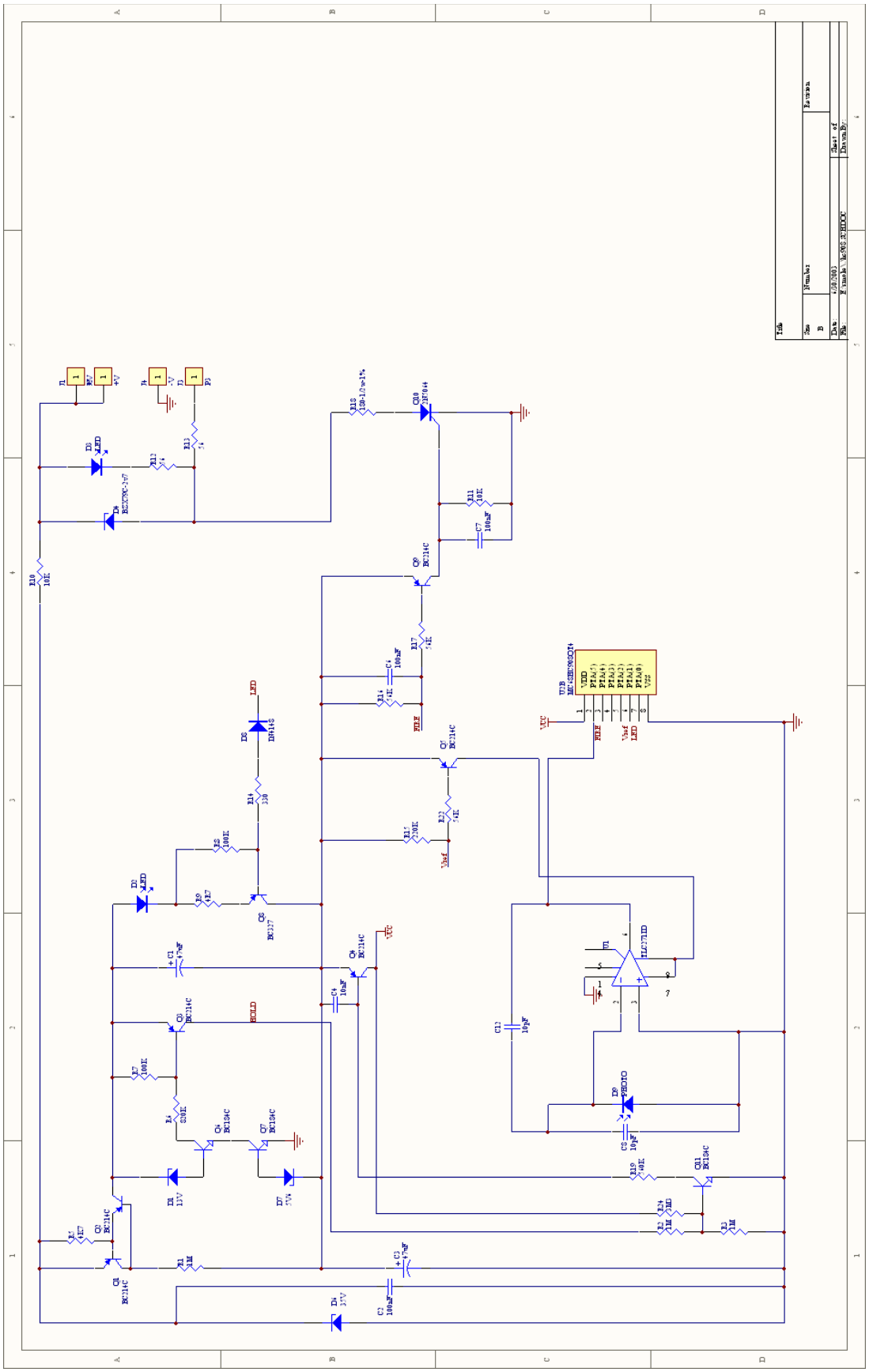
Before the schematic of the smoke detector is discussed, let me just briefly mention how this optical smoke detector 'sees' the smoke.

Like the ionization smoke detector, the optical smoke detector also has a smoke chamber, however, instead of radioactive material, a pair of infra-red transmitter/receiver is placed within the chamber. Picture 2 shows the smoke chamber assembly.



Picture 2: The smoke chamber

Within the smoke chamber, the IR transmitter is placed at an angle to the IR receiver such that under normal conditions, minimal transmitted IR rays reach the IR receiver. However, when there is a presence of smoke particles,



Schematic 5: The complete circuit schematic

All the Parts for the Smoke Detector