Introduction

The BA45F66xx series of MCUs are applicable for use in development of PIR and microwave products. This text will mainly describe PIR applications to introduce how to setup an analog front end circuit which includes an OPA and several peripherals. This text will help users to develop their products more rapidly.

Functional Description

As shown in the block diagram, a very small signal will be generated when the sensor detects a moving object. The signal needs to be processed before being passed to the MCU. Both the PIR and microwave sensors have the same signal processing circuit, however this text will use the PIR sensor as an example.

1. The PIR product detects the difference in temperature between the moving object and the background, after which it generates a corresponding action.
2. Microwave adopts the Doppler principle to detect frequency deviations caused by moving objects and then generates a corresponding action.
3. Since the PIR and the microwave output signals are similar, in terms of the signal processing circuit, the same architecture can be adopted and fine-tuning implemented according to specific application requirements.

Operating Principles

This chapter will take the PIR sensor as an example to explain the signal processing circuit. For microwave sensors or different application requirements and environments, the component values and operational amplifier gain settings may differ. They should be adjusted according to actual requirements.
PIR – Signal Processing Circuit

The circuit is mainly divided into three parts.

- **PIR Sensor**
  - The power supply is provided by the internal LDO output to ensure the stability of the PIR output signal.
  - Due to the sensor structure, the S terminal output signal is a current signal, which must pass through the R2 resistance to generate a voltage to send to the OPA.

- **Band pass Filter**
  - After the PIR output signal has been received, the signal needs to pass through a filter to avoid erroneous actions.
  - R3 and C4 form a high-pass filter with a cut-off frequency of \( \frac{1}{2\pi \times R3 \times C4} = 0.328\text{Hz} \)
  - R4 and C5 form a low-pass filter with a cut-off frequency of \( \frac{1}{2\pi \times R4 \times C5} = 7.957\text{Hz} \)
  - Since the PIR sensor is mainly used to detect human body movement, the frequency of the signal to be amplified is usually from 0.3Hz to 8Hz, this should be adjusted according to the application conditions.
  - The processed signal is first AC coupled after which it is amplified by the second stage OPA.

- **Inverting Amplifier**
  - The second stage OPA non-inverting input can be set to \( 0.5 \times V_{DD} \) by the internal register.
  - Therefore, the second stage OPA output will be biased at a voltage of \( 0.5 \times V_{DD} \).
  - If it is necessary to increase the PIR sensor sensing distance and sensitivity, users can adjust the operational amplifier gain using the PGAC bit field.
For the sensor power supply it is recommended to use the internal LDO output to avoid the signal being influenced by voltage fluctuations.

For PIR sensor applications, it is not necessary to implement operational amplifier offset calibration, here the OnOFM and OnRSP bits should be set to 00. If the operational amplifier offset calibration is required, refer to the corresponding datasheet for details.

Set VPSW/OPA1SW=1 to increase the output level to ensure that the output waveform is easier to observe and the signal is large enough to be detected by the A/D converter.

The second stage OPA amplifier is a programmable gain amplifier whose gain can be set to have a range of 128 to 376. The gain can be adjusted according to the actual application requirements, this is proportional to the detection distance and sensitivity.

The OPAs have four bandwidth options, since the PIR sensor is used to detect human movement which is a low-frequency application, the OPAnBW[1:0] bits should be set to 00. At this time, the OPAn bandwidth is 5kHz, which can meet the PIR application requirements. The bandwidth is directly proportional to power consumption. Refer to the datasheet for the different bandwidth and their corresponding power consumption details.

If it is required to reduce the warm-up time, refer to the Fast Warm-up section for details.
Fast Warm-up

- In applications, OPA0 will be connected to a negative feedback resistor with a resistance value of 1MΩ. Therefore the charging time of an external capacitor with a capacitance value of 22μF will be limited by this resistor to reach its limitation, as shown in figure 3.
- Switching the OPA0SW, S1 and S0 switches on will make the negative feedback resistance low. At this time, the circuit will be formed into a voltage follower. The charging path is shown by the red line in figure 3.
- The circuit can be used to reduce the warm-up time during the PIR initialisation by reducing the time required to fully charge the capacitor.

Conclusion

This application guideline has introduced the BA45F66xx series PIR/microwave sensor special MCU setup method which will help users to quickly develop their products and improve product stability in practical applications.

Reference Files

For more information, refer to the Holtek official website http://www.holtek.com.

Versions and Modify Information

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Issue Release and Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019.06.26</td>
<td>Jia-Chieng, Wu</td>
<td>First Version</td>
</tr>
</tbody>
</table>
Disclaimer

Disclaimer

All information, trademarks, logos, graphics, videos, audio clips, links and other items appearing on this website (Information) are for reference only and is subject to change at any time without prior notice and at the discretion of Holtek Semiconductor Inc. and its related companies (hereinafter Holtek, the company, us, we or our). Whilst Holtek endeavors to ensure the accuracy of the Information on this website, no express or implied warranty is given by Holtek to the accuracy of the Information. Holtek shall bear no responsibility for any incorrectness or leakage. Holtek shall not be liable for any damages (including but not limited to computer virus, system problems or data loss) whatsoever arising in using or in connection with the use of this website by any party. There may be links in this area, which allow you to visit the websites of other companies. These websites are not controlled by Holtek. Holtek will bear no responsibility and no guarantee to whatsoever Information displayed at such sites. Hyperlinks to other websites are at your own risk.

Limitation of Liability

In no event shall Holtek Limited be liable to any other party for any loss or damage whatsoever or howsoever caused directly or indirectly in connection with your access to or use of this website, the content thereon or any goods, materials or services.

Governing Law

The Disclaimer contained in the website shall be governed by and interpreted in accordance with the laws of the Republic of China. Users will submit to the non-exclusive jurisdiction of the Republic of China courts.

Update of Disclaimer

Holtek reserves the right to update the Disclaimer at any time with or without prior notice, all changes are effective immediately upon posting to the website.