NCS36000GEVB

NCS36000 PIR Sensor Evaluation Board User's Manual

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EVAL BOARD USER'S MANUAL

General

The Passive InfraRed (PIR) sensor evaluation board is designed to evaluate the NCS36000, a fully integrated mixed-signal CMOS device designed for low-cost passive infrared controlling applications. This device integrates two low-noise amplifiers and a LDO regulator to drive the sensor. The output of the amplifiers goes to a window comparator that uses internal voltage references from the regulator. The detection logic processes the output from the window comparator and provides the output to the 'OUT' pin. A blinking LED indicates startup and depending on the status of the 'LED_EN' pin the LED also lights up when a valid movement is detected.

The EVB can be powered from a micro-USB cable connected to a host-USB interface (e.g. pc). Alternatively an external power source ranging from 4–9 V can be connected to pins 'GND' and '+' of the 3 pins header 'H1'.

General Usage

Power the evaluation board by plugging a micro-USB cable in connector USB1 or by connecting an external power source with a voltage ranging 4–9 V DC between 'GND' and '+' terminal of pin header H1.

After power up, the LED1 starts blinking. This lasts about 30 seconds depending on the 'TIMER' setting. When LED1 stops blinking, the evaluation board is ready for normal operation.

There are two potentiometers on the board. One is labeled 'SENSITIVITY' which controls the gain of the band-pass filter. For more information, see the 'Filter characteristics' section. The other potentiometer is labeled 'TIMER' and controls the system oscillator frequency. Its setting affects the logic subsystems that determine if a movement is detected or not. For more information see the 'Timing characteristics' section.

Wave your hand above the Fresnel lens. This motion is detected when LED1 turns on. Simultaneously the logic level on the 'OUT' pin of pin header 'H1' is high. 'OUT' is the output of the digital signal processing block. It is possible to monitor the input of the window comparator by probing the 'OP2_O' test pin 'TP2'.

The total current consumption of the application can easily be measured by removing the 0 Ω jumper marked 'CURR' and putting an Amp meter in series.

Jumpers JP3 (MODE) and JP5 (LED Enable) has following function:

Table 1. JUMPER SETTING

Jumper	State	Function
MODE	Open	Dual Pulse Mode
MODE	Close	Single Pulse Mode
LED EN	Open	LED will Not Toggle*
LED EN	Close	LED Toggles after Motion Detected

* During start-up LED1 will blink for about 30 s. After this initialization period the LED is disabled.

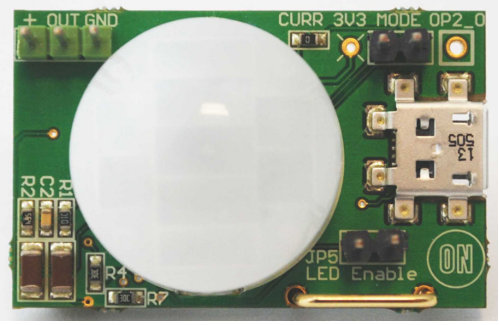

Figure 1. Top View of Evaluation Board

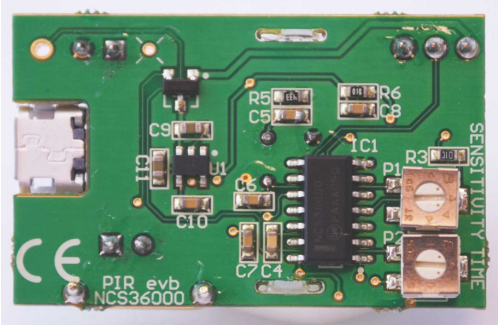

Figure 2. Bottom View of Evaluation Board

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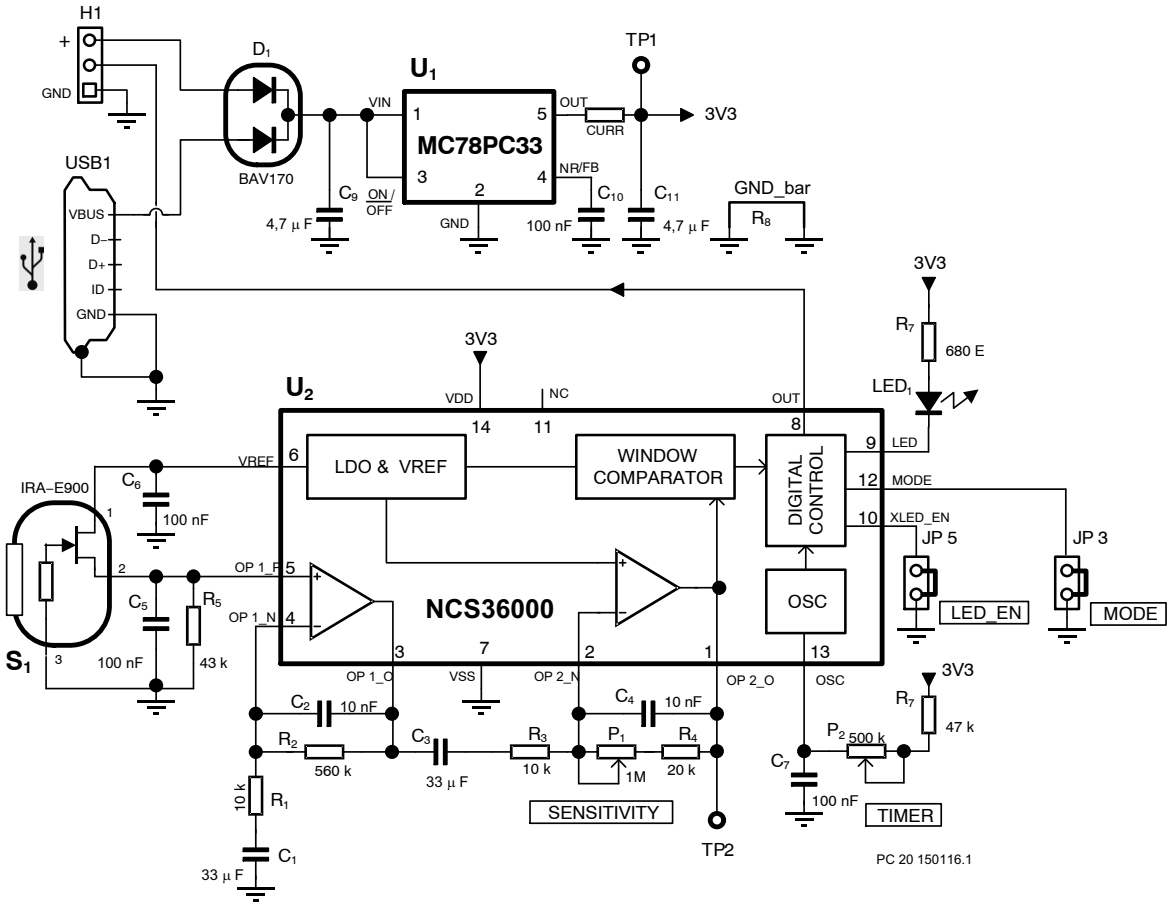

Figure 3. Schematic Diagram

Filter Characteristics

The band-pass filter is built around 2 low noise operational amplifiers as illustrated in Figure 3. The gain is determined by:

$$G[dB] = 20 \cdot \log\left\{\left[1 + \frac{R_2}{R_1}\right] \cdot \left[1 + \frac{P_1 + R_4}{R_3}\right]\right\} \quad \text{(eq. 1)}$$

Example:

$$G[dB] = 20 \cdot \log\left\{\left[1 + \frac{560k}{10k}\right] \cdot \left[1 + \frac{800k}{10k}\right]\right\} \quad \text{(eq. 2)}$$

$$G[dB] = 73.3\ dB$$

The lower cut-off frequency is mainly determined by poles formed by $R_1 - C_1$ and $R_3 - C_3$. The higher cut-off frequency is dominated by the pole formed by $(P_1 + R_4) - C_4$.

The table shows the gain and the cut-off frequencies for different values of $P_1 + R_4$ combination, where P1is the 'SENSITIVITY' potentiometer.

Table 2. GAIN SETTING

P1 + R4	Gain	f_{-3dB} Lo	f_{-3dB} Hi
300 kΩ	64.4 dB	0.72 Hz	24.3 Hz
500 kΩ	68.8 dB	0.71 Hz	20.4 Hz
700 kΩ	71.7 dB	0.71 Hz	16.7 Hz
800 kΩ	72.8 dB	0.70 Hz	16.0 Hz
900 kΩ	73.8 dB	0.70 Hz	14.8 Hz
1,1 MΩ	75.5 dB	0.69 Hz	13.1 Hz
1,3 MΩ	76.9 dB	0.69 Hz	11.7 Hz

In Figure 4 gain versus frequency is plotted for different potentiometer settings.

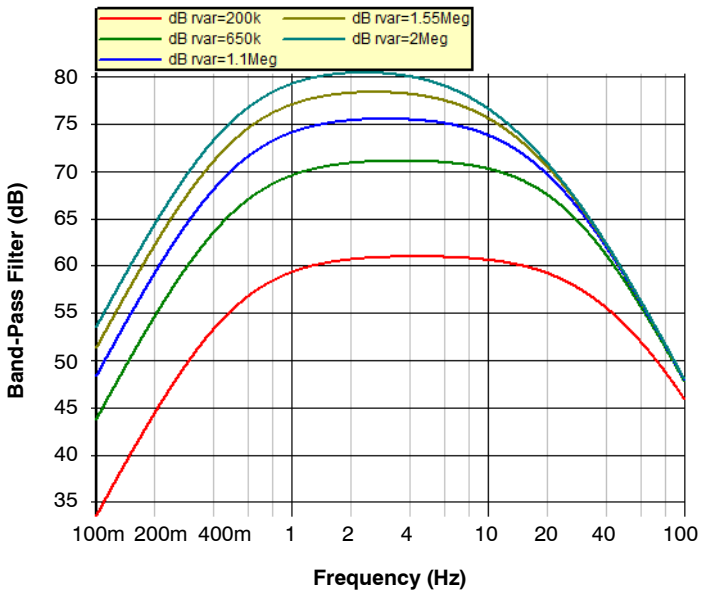

Figure 4. Gain of the Band-Pass Filter vs. Frequency; $R_{VAR} = P_1 + R_4$

Timing Characteristics

Potentiometer P_2, marked 'TIMER' sets the oscillator frequency, which is the clock of the detection system. Changing the frequency influences the reaction time and the sensitivity of the system.

In single pulse mode (Jumper JP3 "MODE" closed) a signal from the sensor is detected when the amplitude at the window comparator input exceeds V_H (positive threshold) or V_L (negative threshold) AND the pulse duration T_{SP} is at least 3 clock periods:

$$T_{SP} > 3 \cdot T_{CLK} \qquad \text{(eq. 3)}$$

This will trigger a mono-flop and 'OUT' will be toggled high for 120 clock periods.

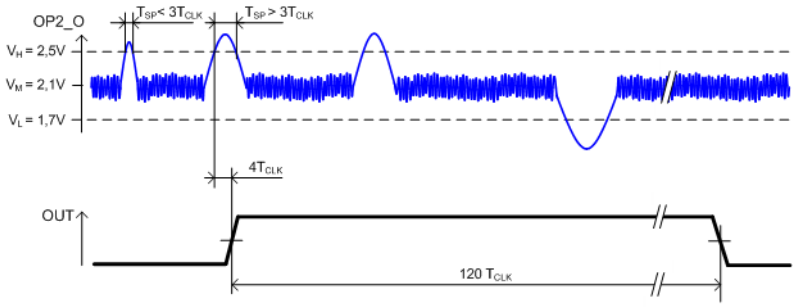

Figure 5. Single Pulse Detection

In dual pulse mode (Jumper JP3 "MODE" removed), 2 consecutive pulses will trigger the mono-flop when the interval TDP between these 2 consecutive pulses is less than 360 clock cycles:

$$T_{DP} < 360 \cdot T_{CLK} \qquad \text{(eq. 4)}$$

The oscillator clock period depends on $P_2 + R_7$ and C_7 and can be calculated as:

$$T_{CLK} = (P_2 + R_7) \cdot C_7 \cdot 0.727 \qquad \text{(eq. 5)}$$

A good choice for most applications is a clock period T_{CLK} = 16 ms, equivalent to an oscillator frequency, f_{CLK} = 62.5 Hz. From equation 5 this corresponds with $P_2 + R_7$ = 220 kΩ and C_7 = 100 nF. By using equations 3 and 4 this results in T_{SP} = 48 ms and T_{DP} = 5,76 s.

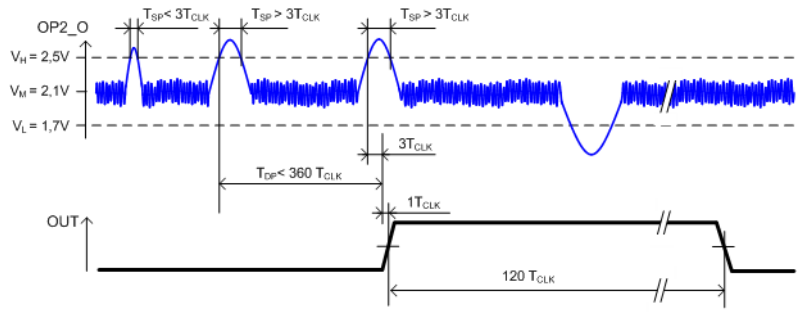

Figure 6. Dual Pulse Detection

Interfacing Microcontroller

The easiest way to connect a MCU development PCB to the PIR sensor evaluation board is by using pin header H1. Power and ground connections can be shared and the logic levels are 3,3 V compliant. By connecting "OUT" to a general purpose I/O of the microcontroller the sensor output can be easily monitored.

It is possible to control the evaluation board more advanced, but this requires some additional wiring. Some suggestions are illustrated in Figure 7 described in the next paragraphs.

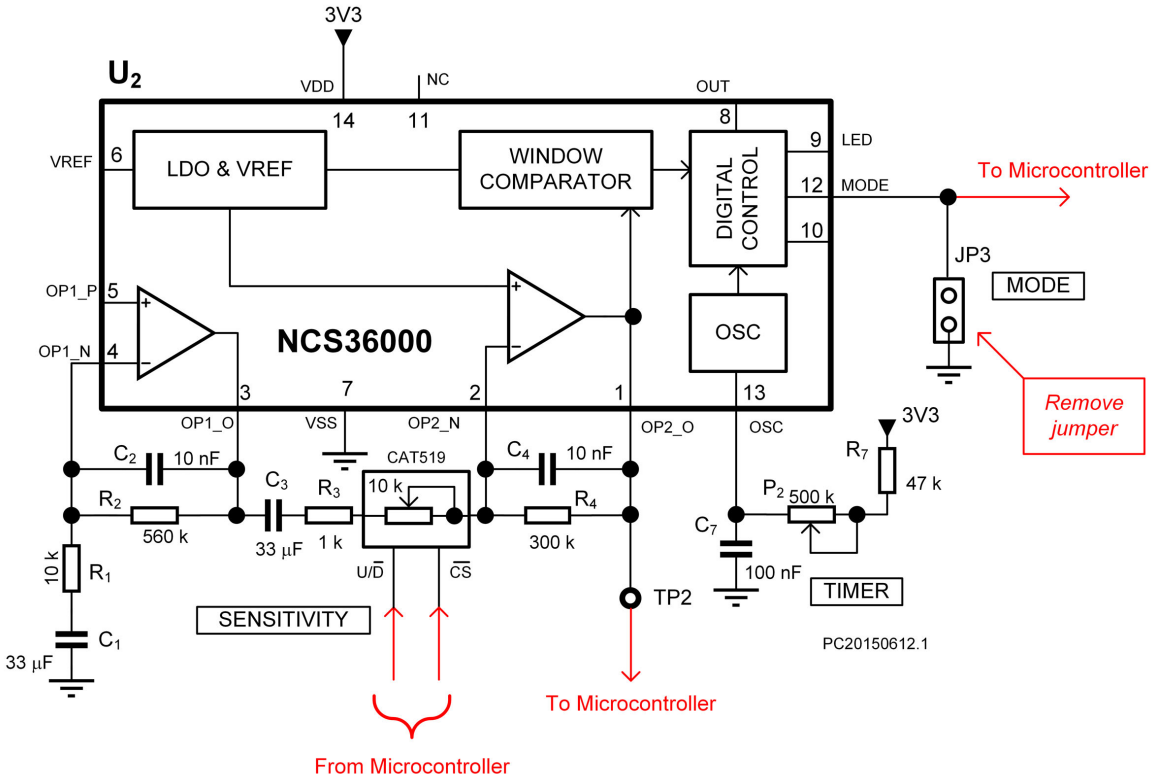

Figure 7. Schematic Diagram

Motion detection is influenced by the mode of operation. In single pulse mode the output toggles for every pulse received under the condition the amplitude and duration are high enough. In dual pulse mode 2 consecutive pulses need to be detected. This avoids false detections. By connecting the MODE input (JP3) directly to an I/O of the microcontroller this selection can be made in software.

The sensitivity is set by the gain of low noise amplifier 2. See Table 2. In series of R_3 a digital potentiometer can be placed controlled by the microcontroller. P_1 is removed and R_4 is set to 300 kΩ. See Figure 7 where a CAT5119 in the 10 k version is used needing only 2 control lines. Increasing the gain will extend the detection range.

Test-point TP2 is the output of the second low noise amplifier. It is possible to bypass the integrated Detection Logic of NCS36000 by connecting TP2 to an ADC of an external microcontroller. This allows the user to build a customized detection algorithm in software.

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