NCS36000GEVB

NCS36000 PIR Sensor Evaluation Board User's Manual

ON Semiconductor®

www.onsemi.com

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.

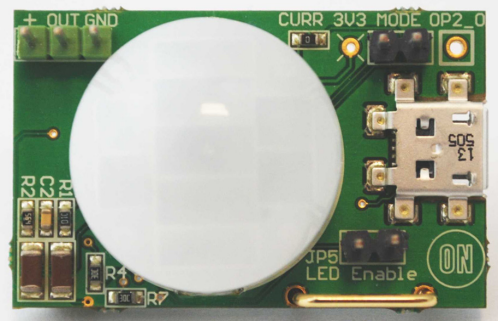


Figure 1. Top View of Evaluation Board

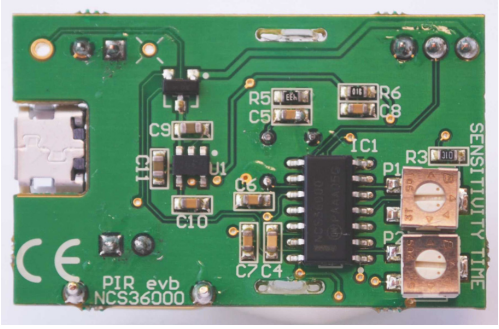


Figure 2. Bottom View of Evaluation Board

© Semiconductor Components Industries, LLC, 2015

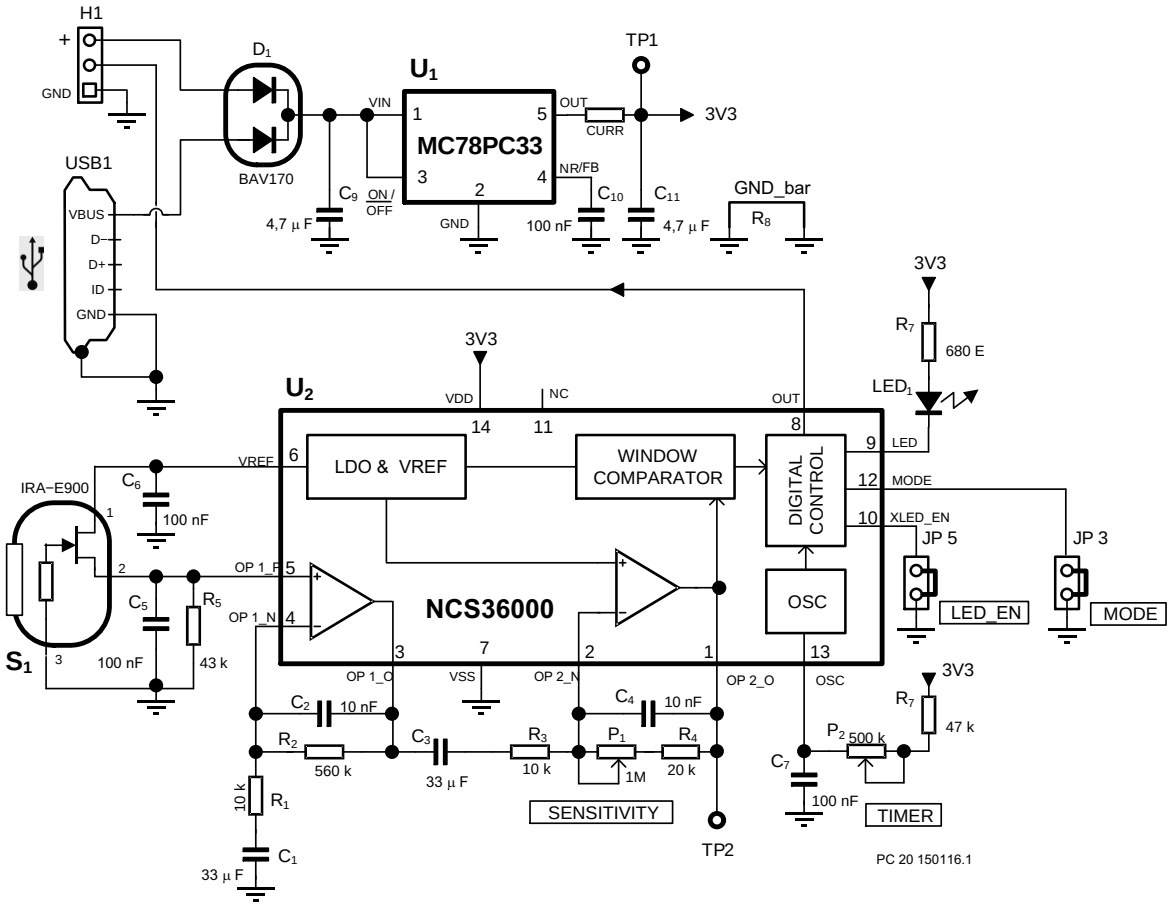


Figure 3. Schematic Diagram

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.

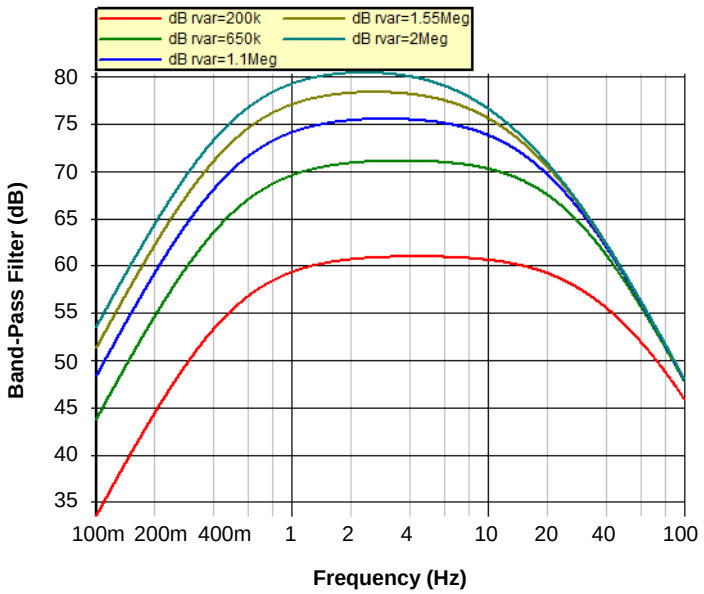


Figure 4. Gain of the Band-Pass Filter vs. Frequency; $R_{VAR} = P_1 + R_4$

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.

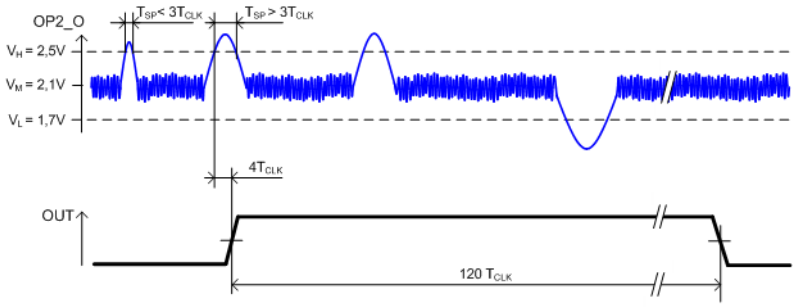


Figure 5. Single Pulse Detection

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.

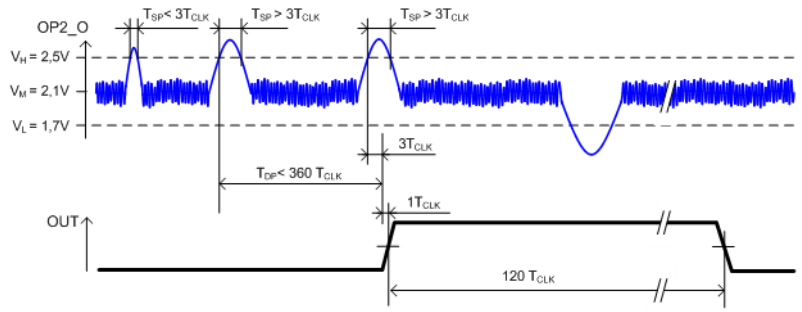


Figure 6. Dual Pulse Detection

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.

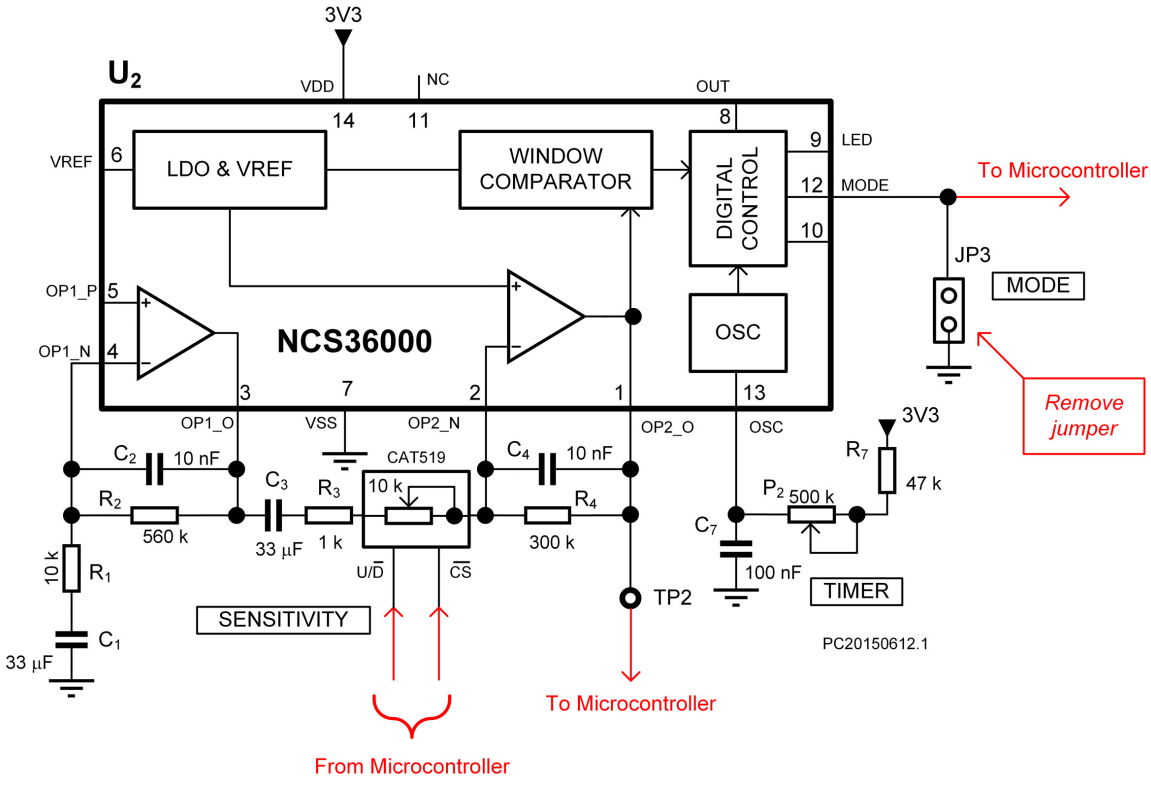


Figure 7. Schematic Diagram

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.

ON Semiconductor and the ON are registered trademarks of Semiconductor Components Industries, LLC (SCILLC) or its subsidiaries in the United States and/or other countries. SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent−Marking.pdf. SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

EVBUM2304/D

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

ON Semiconductor:

NCS36000GEVB