

# NCS36000GEVB

## NCS36000 PIR Sensor Evaluation 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

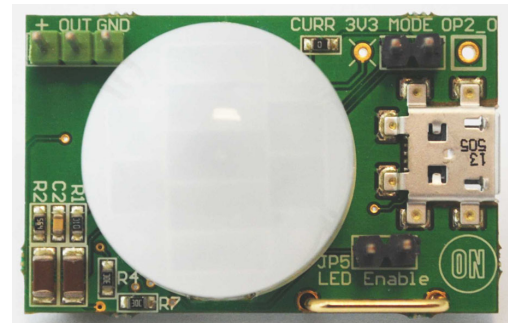
\* During start-up LED1 will blink for about 30 s. After this initialization period the LED is disabled.



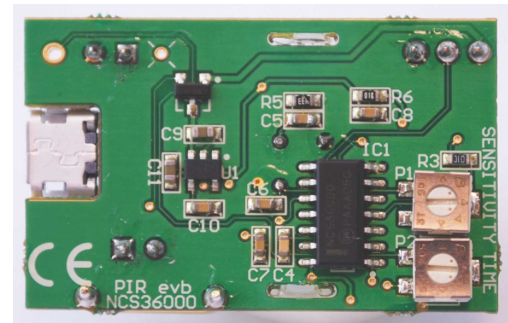
**ON Semiconductor®**

[www.onsemi.com](http://www.onsemi.com)

## EVAl BOARD USER'S MANUAL



**Figure 1. Top View of Evaluation Board**



**Figure 2. Bottom View of Evaluation Board**

# NCS36000GEVB

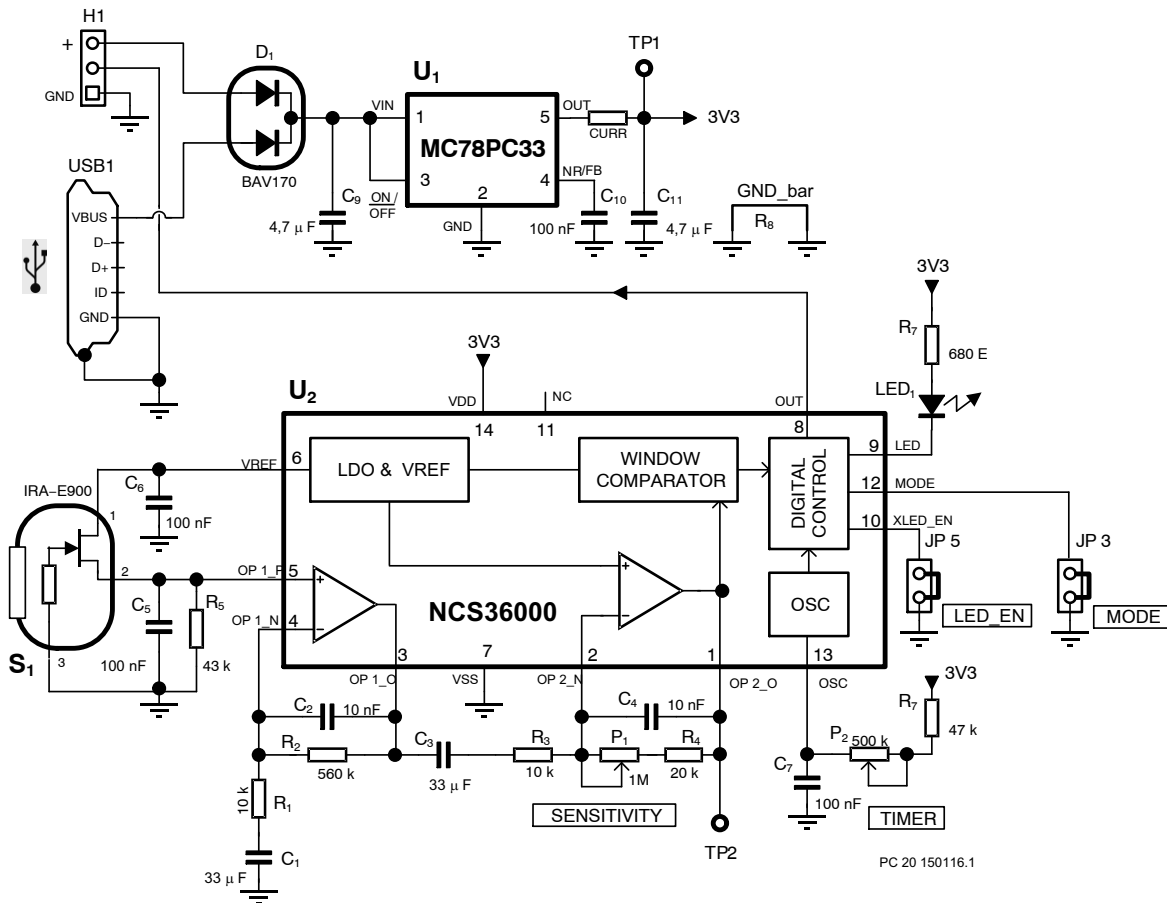


Figure 3. Schematic Diagram

## Filter Characteristics

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

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

Example:

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

$$G[\text{dB}] = 73.3 \text{ dB}$$

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  $P_1$  is the 'SENSITIVITY' potentiometer.

Table 2. GAIN SETTING

$P_1 + R_4$	Gain	$f_{-3\text{dB Lo}}$	$f_{-3\text{dB Hi}}$
300 k $\Omega$	64.4 dB	0.72 Hz	24.3 Hz
500 k $\Omega$	68.8 dB	0.71 Hz	20.4 Hz
700 k $\Omega$	71.7 dB	0.71 Hz	16.7 Hz
800 k $\Omega$	72.8 dB	0.70 Hz	16.0 Hz
900 k $\Omega$	73.8 dB	0.70 Hz	14.8 Hz
1,1 M $\Omega$	75.5 dB	0.69 Hz	13.1 Hz
1,3 M $\Omega$	76.9 dB	0.69 Hz	11.7 Hz

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

# NCS36000GEVB

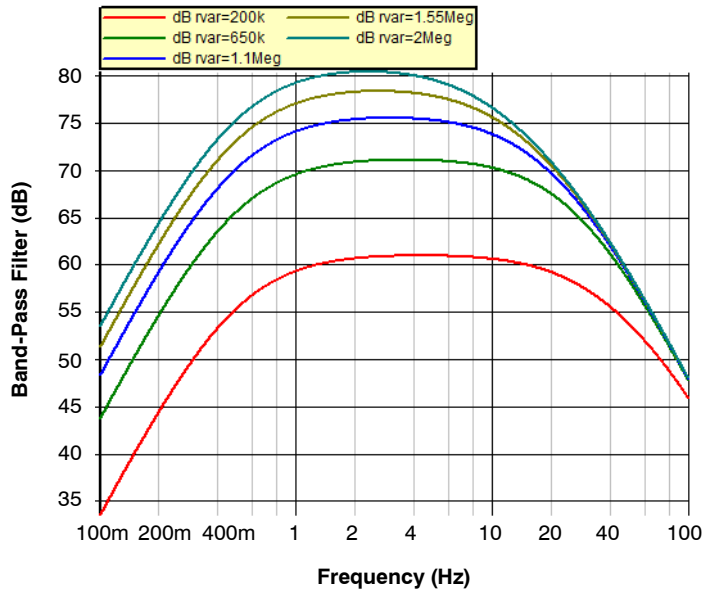


Figure 4. Gain of the Band-Pass Filter vs. Frequency;  $R_{VAR} = P_1 + R_4$

### Timing Characteristics

Potentiometer P<sub>2</sub>, 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<sub>H</sub> (positive threshold) or V<sub>L</sub> (negative threshold) AND the pulse duration T<sub>SP</sub> is at least 3 clock periods:

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

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

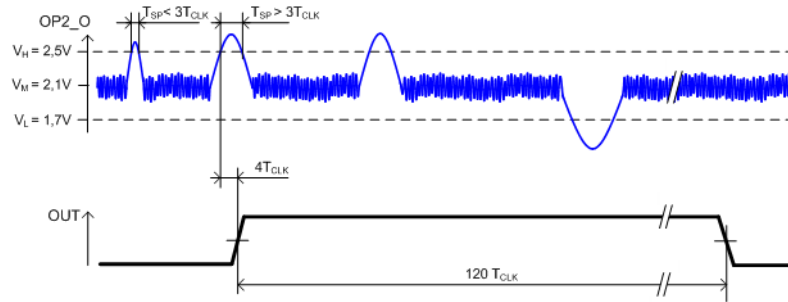


Figure 5. Single Pulse Detection

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:

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

The oscillator clock period depends on P<sub>2</sub> + R<sub>7</sub> and C<sub>7</sub> and can be calculated as:

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

A good choice for most applications is a clock period T<sub>CLK</sub> = 16 ms, equivalent to an oscillator frequency, f<sub>CLK</sub> = 62.5 Hz. From equation 5 this corresponds with P<sub>2</sub> + R<sub>7</sub> = 220 kΩ and C<sub>7</sub> = 100 nF. By using equations 3 and 4 this results in T<sub>SP</sub> = 48 ms and T<sub>DP</sub> = 5,76 s.

# NCS36000GEVB

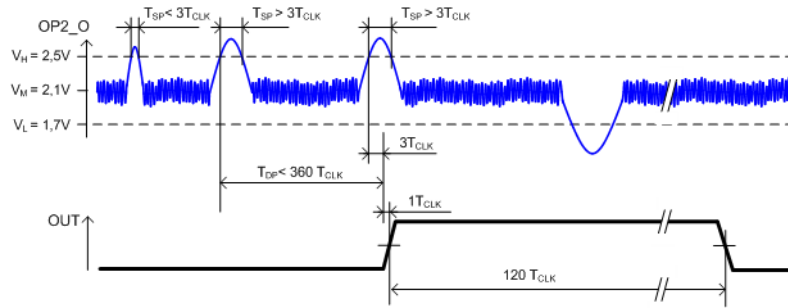


Figure 6. Dual Pulse Detection

## 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.

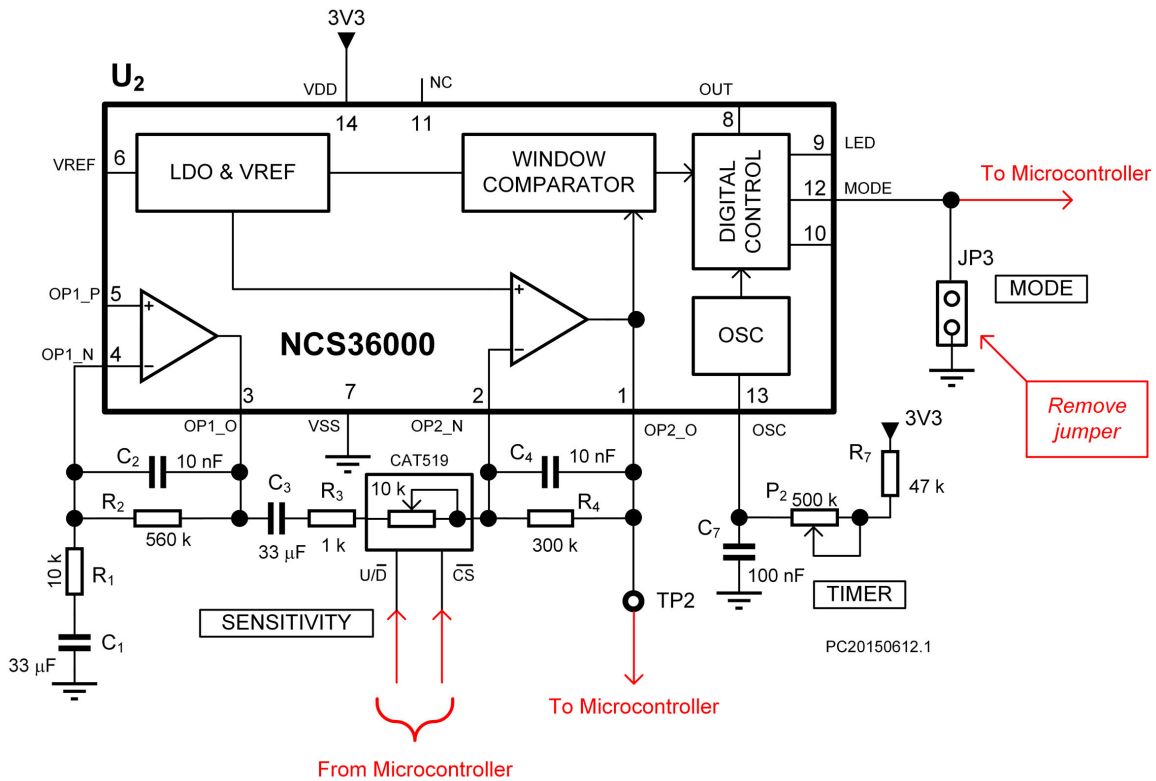


Figure 7. Schematic Diagram

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<sub>3</sub> a digital potentiometer can be placed controlled by the microcontroller. P<sub>1</sub> is removed and R<sub>4</sub> 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.

## NCS36000GEVB

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 Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

The evaluation board/kit (research and development board/kit) (hereinafter the "board") is not a finished product and is as such not available for sale to consumers. The board is only intended for research, development, demonstration and evaluation purposes and should as such only be used in laboratory/development areas by persons with an engineering/technical training and familiar with the risks associated with handling electrical/mechanical components, systems and subsystems. This person assumes full responsibility/liability for proper and safe handling. Any other use, resale or redistribution for any other purpose is strictly prohibited.

The board is delivered "AS IS" and without warranty of any kind including, but not limited to, that the board is production-worthy, that the functions contained in the board will meet your requirements, or that the operation of the board will be uninterrupted or error free. ON Semiconductor expressly disclaims all warranties, express, implied or otherwise, including without limitation, warranties of fitness for a particular purpose and non-infringement of intellectual property rights.

ON Semiconductor reserves the right to make changes without further notice to any board.

You are responsible for determining whether the board will be suitable for your intended use or application or will achieve your intended results. Prior to using or distributing any systems that have been evaluated, designed or tested using the board, you agree to test and validate your design to confirm the functionality for your application. Any technical, applications or design information or advice, quality characterization, reliability data or other services provided by ON Semiconductor shall not constitute any representation or warranty by ON Semiconductor, and no additional obligations or liabilities shall arise from ON Semiconductor having provided such information or services.

The boards are not designed, intended, or authorized for use in life support systems, or any FDA Class 3 medical devices or medical devices with a similar or equivalent classification in a foreign jurisdiction, or any devices intended for implantation in the human body. Should you purchase or use the board for any such unintended or unauthorized application, you shall indemnify and hold ON Semiconductor 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 ON Semiconductor was negligent regarding the design or manufacture of the board.

This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the technical requirements of these or other related directives.

**FCC WARNING** – This evaluation board/kit is intended for use for engineering development, demonstration, or evaluation purposes only and is not considered by ON Semiconductor to be a finished end product fit for general consumer use. It may generate, use, or radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment may cause interference with radio communications, in which case the user shall be responsible, at its expense, to take whatever measures may be required to correct this interference.

ON Semiconductor does not convey any license under its patent rights nor the rights of others.

**LIMITATIONS OF LIABILITY:** ON Semiconductor shall not be liable for any special, consequential, incidental, indirect or punitive damages, including, but not limited to the costs of requalification, delay, loss of profits or goodwill, arising out of or in connection with the board, even if ON Semiconductor is advised of the possibility of such damages. In no event shall ON Semiconductor's aggregate liability from any obligation arising out of or in connection with the board, under any theory of liability, exceed the purchase price paid for the board, if any.

For more information and documentation, please visit [www.onsemi.com](http://www.onsemi.com).

---

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Email Requests to: [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

ON Semiconductor Website: [www.onsemi.com](http://www.onsemi.com)

### TECHNICAL SUPPORT

North American Technical Support:

Voice Mail: 1 800-282-9855 Toll Free USA/Canada

Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:

Phone: 00421 33 790 2910

For additional information, please contact your local Sales Representative