APPLICATION NOTE

Micro Vibration Sensor
MVS1006.01 / MVS0608.02
                MVS0409.02

Revision 1.8   2013 November 11
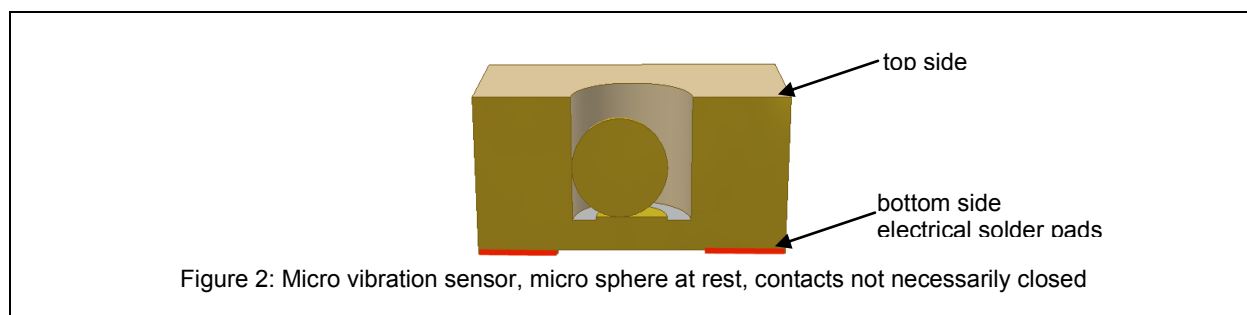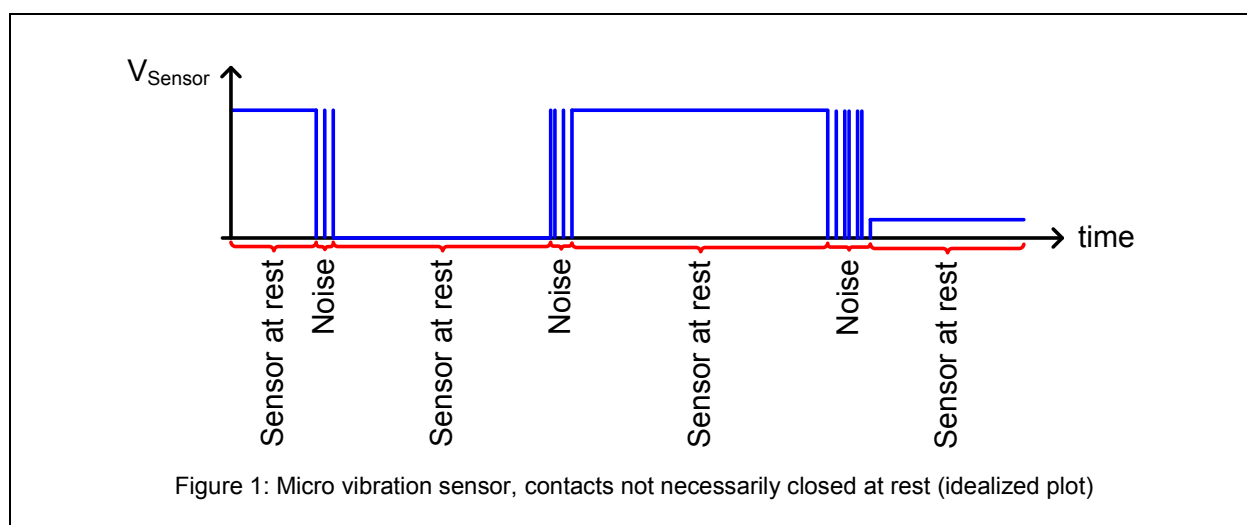Supersedes data of 2010 Nov. 04

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1. Sensor evaluation

Both versions of the micro vibration sensor (unidirectional MVS1006.01 and omnidirectional MVS0608.02/MVS0409.02) are **not necessarily closed** when **at rest**. Only in 70% - 99% of time they will be closed when at rest as shown in Figure 1. The circuit and/or the software of the electronic device should evaluate state changes from open to closed or closed to open instead of steady states open or closed.

If the sensor is at one DC-level (e.g. high), a slight vibration may cause the sensor signal to toggle. This fake motion cannot be filtered out by the "Small filter circuit" and has to be handled by the µC software. If a hardware solution is needed for this situation the DC part of the signal has to be filtered out first by a high pass filter to get a defined rest state output.

Figure 1: Micro vibration sensor, contacts not necessarily closed at rest (idealized plot)

Figure 2: Micro vibration sensor, micro sphere at rest, contacts not necessarily closed

The unidirectional sensor version MVS1006.01 is open at rest, when mounted in upside down position, so that the micro sphere is on the top side of the sensor, which has no contact pad.
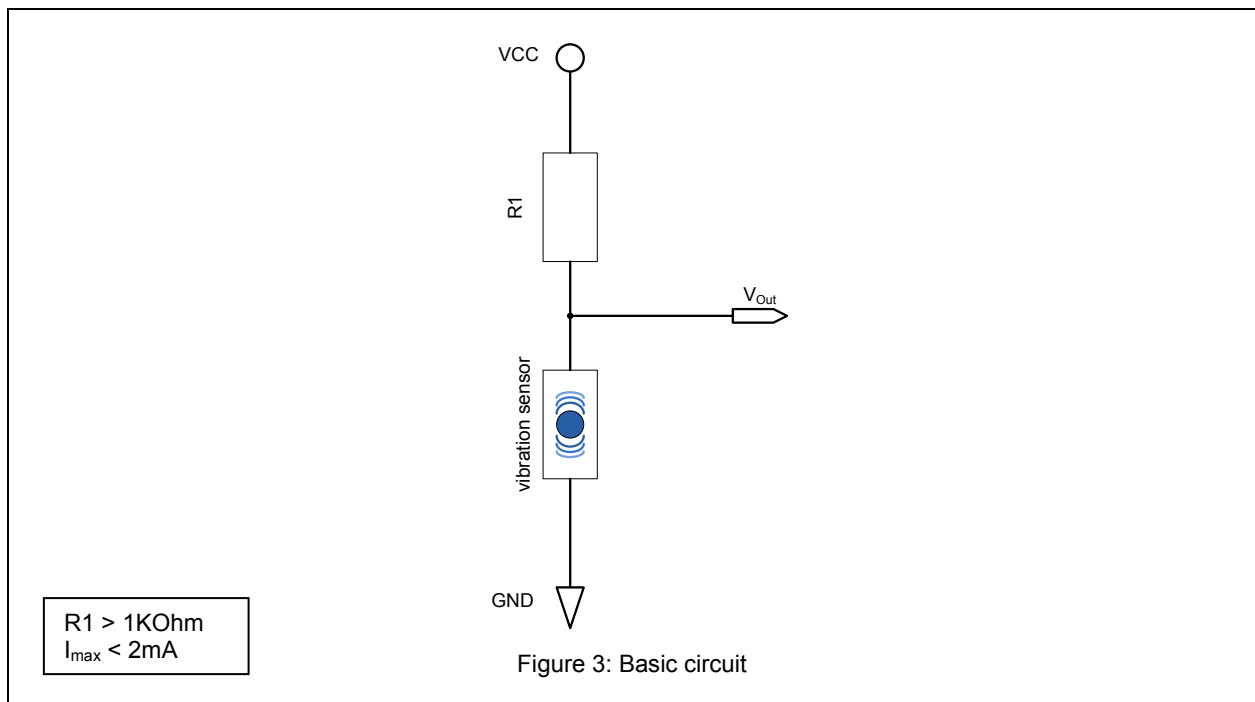
2. Basic circuit

2.1   General description

The most simple circuit with a minimum of component requirement.
R1 should be chosen to limit the maximum current through the sensor to a maximum value of 2mA.

2.2   Circuit

VCC

R1

V_{Out}

vibration sensor

GND

R1 > 1KOhm
I_{max} < 2mA

Figure 3: Basic circuit

3. Filter Circuit

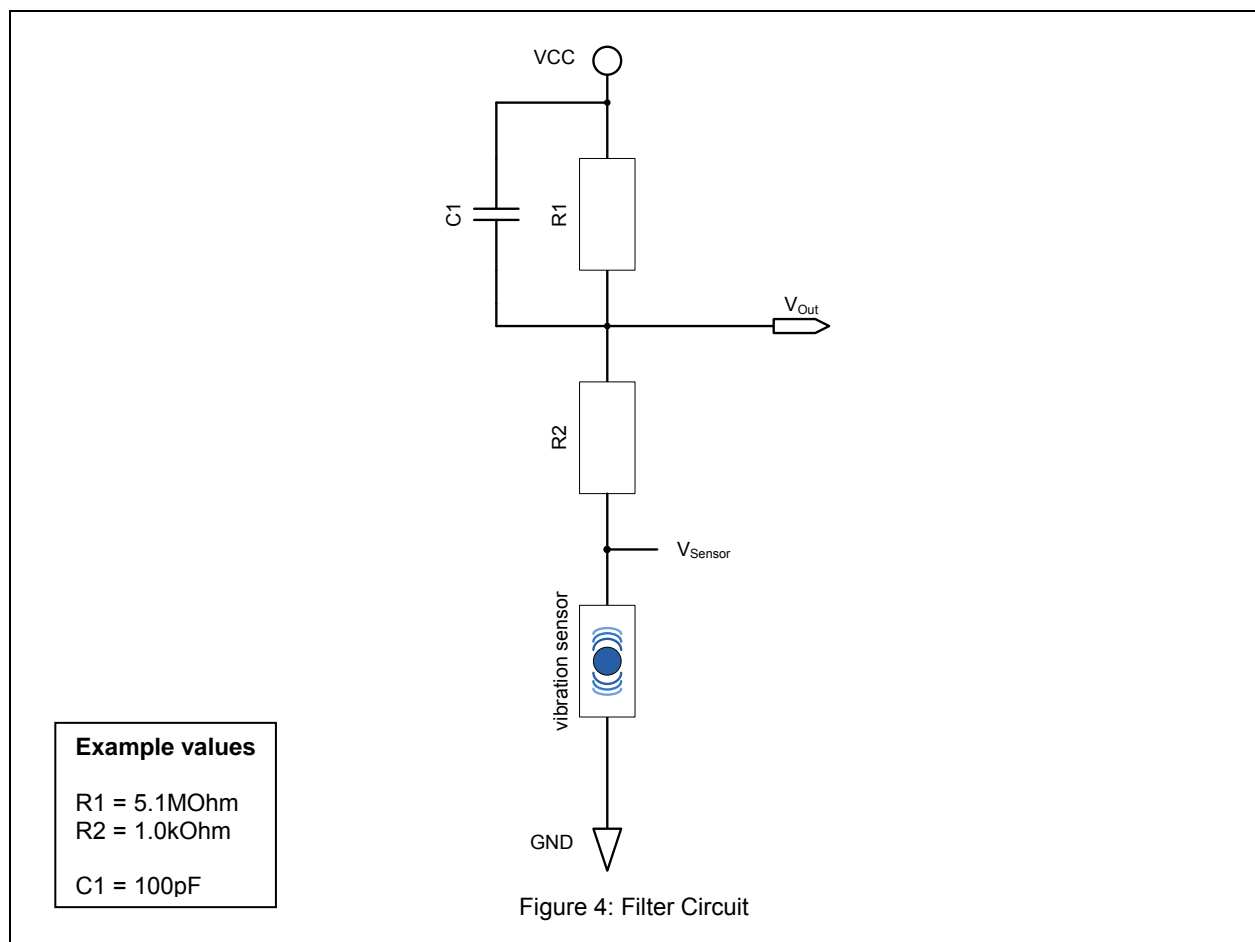## 3.1   General description

In order to reduce the sensitivity of the sensor, a small capacitor can be added to the evaluation circuit presented in Figure 4. Additionally to the capacitor C1 a resistor R2 is applied, which limits the current through the sensor when the capacitor impedance is low.
For low power applications high values of R1 and R2 can be used to limit the current. If high resistor values are used, the circuit impedance must be considered. For the resistive voltage divider a good value of R1 is 5.1M, and R2 can be between 100k and 1M, depending on the desired output voltage swing.
C1 can be varied on a range of 10pF to 1nF for different filter options. A larger C1 value e.g. 100nF will turn the peaks of the output into an analog average value shown in Figure 5.
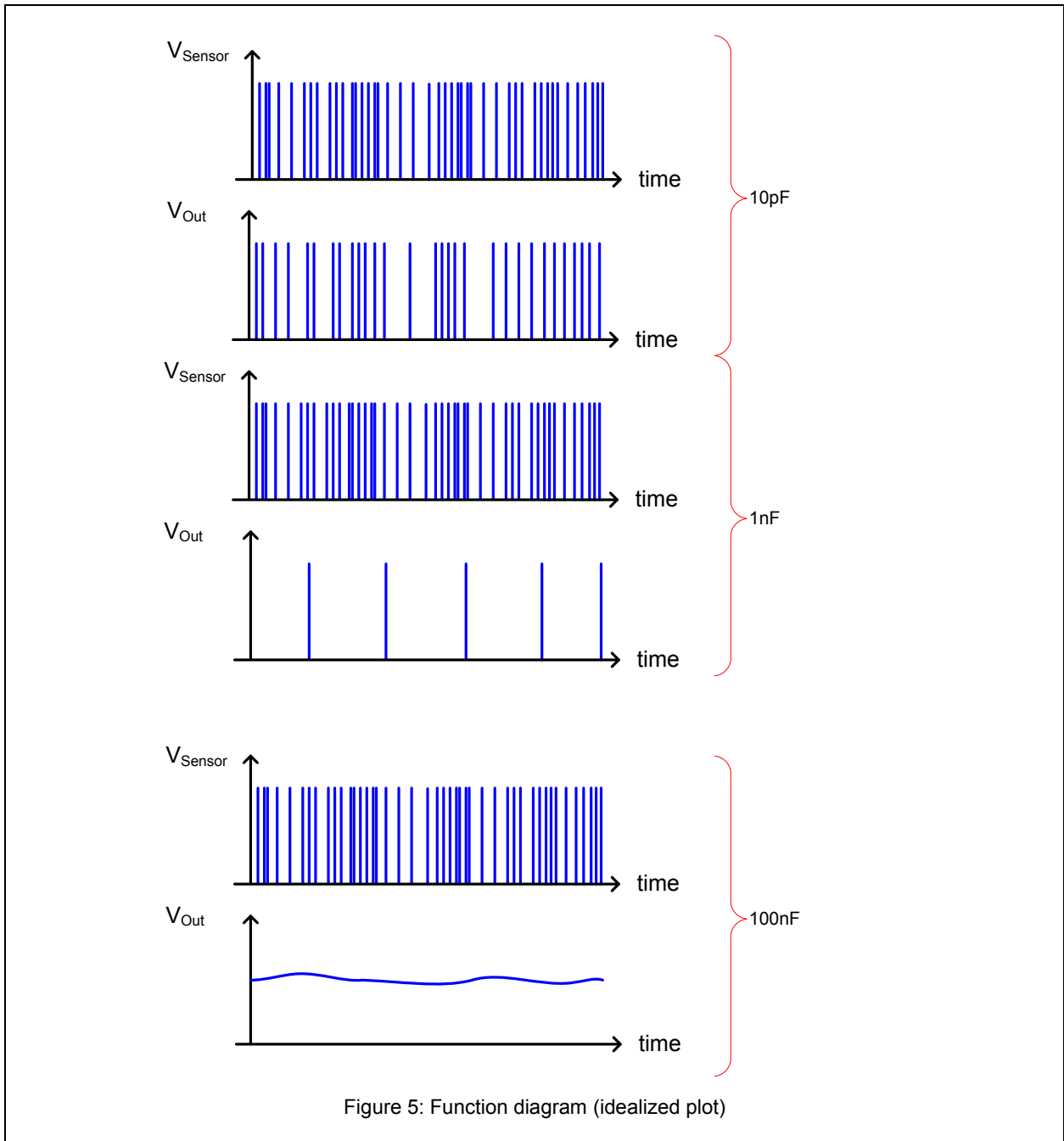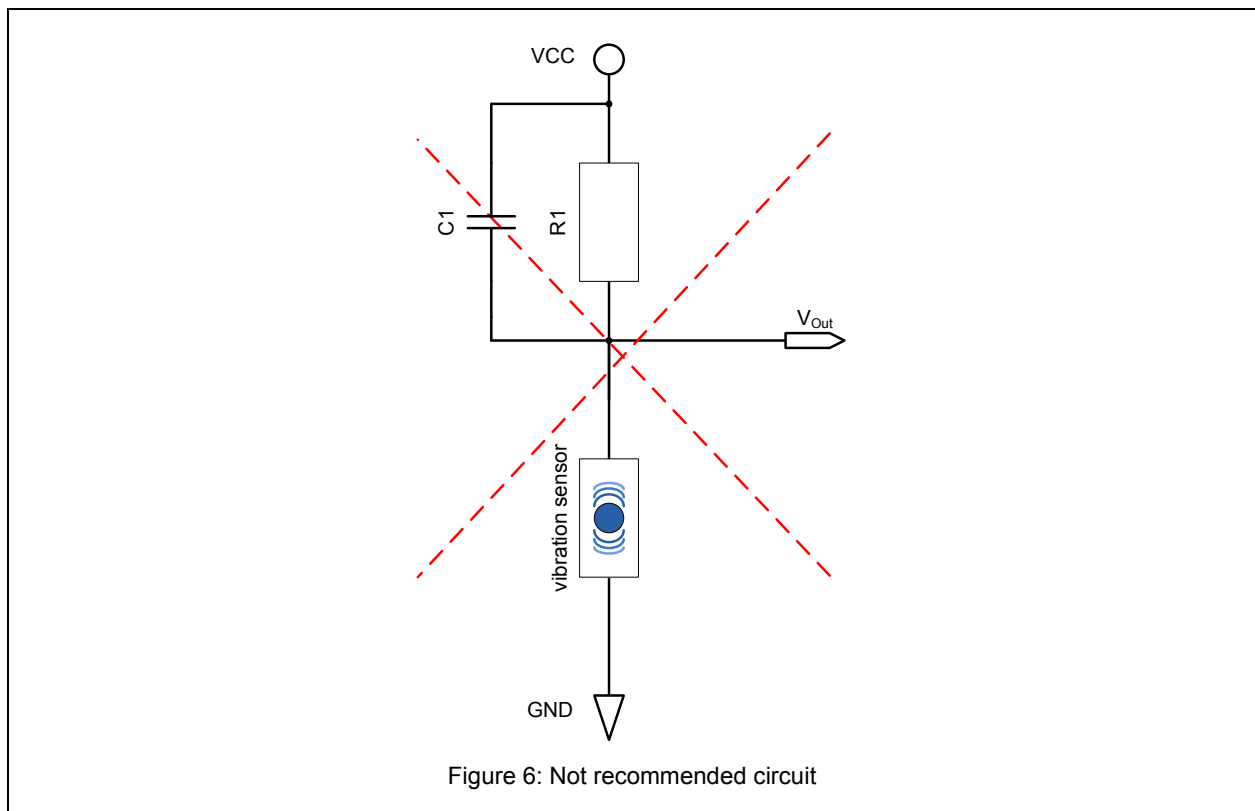
3.2   Circuit

Example values

R1 = 5.1MOhm
R2 = 1.0kOhm

C1 = 100pF

Figure 4: Filter Circuit

Figure 5: Function diagram (idealized plot)

4. Not recommended circuit

4.1 General description

It's not recommended to connect a capacity from any supply directly to the sensor. When the sensing mechanism opens and closes, a large inrush current will occur. It will potentially damage the contacts and reduce life of the Sensor.

4.2 Circuit

Figure 6: Not recommended circuit

5. Measuring Note

When measuring with an oscilloscope, it is recommended to use the 10x probe for circuit debugging. If 1x probe is used, the series resistance will cause a large voltage drop.

6. Defined rest state output
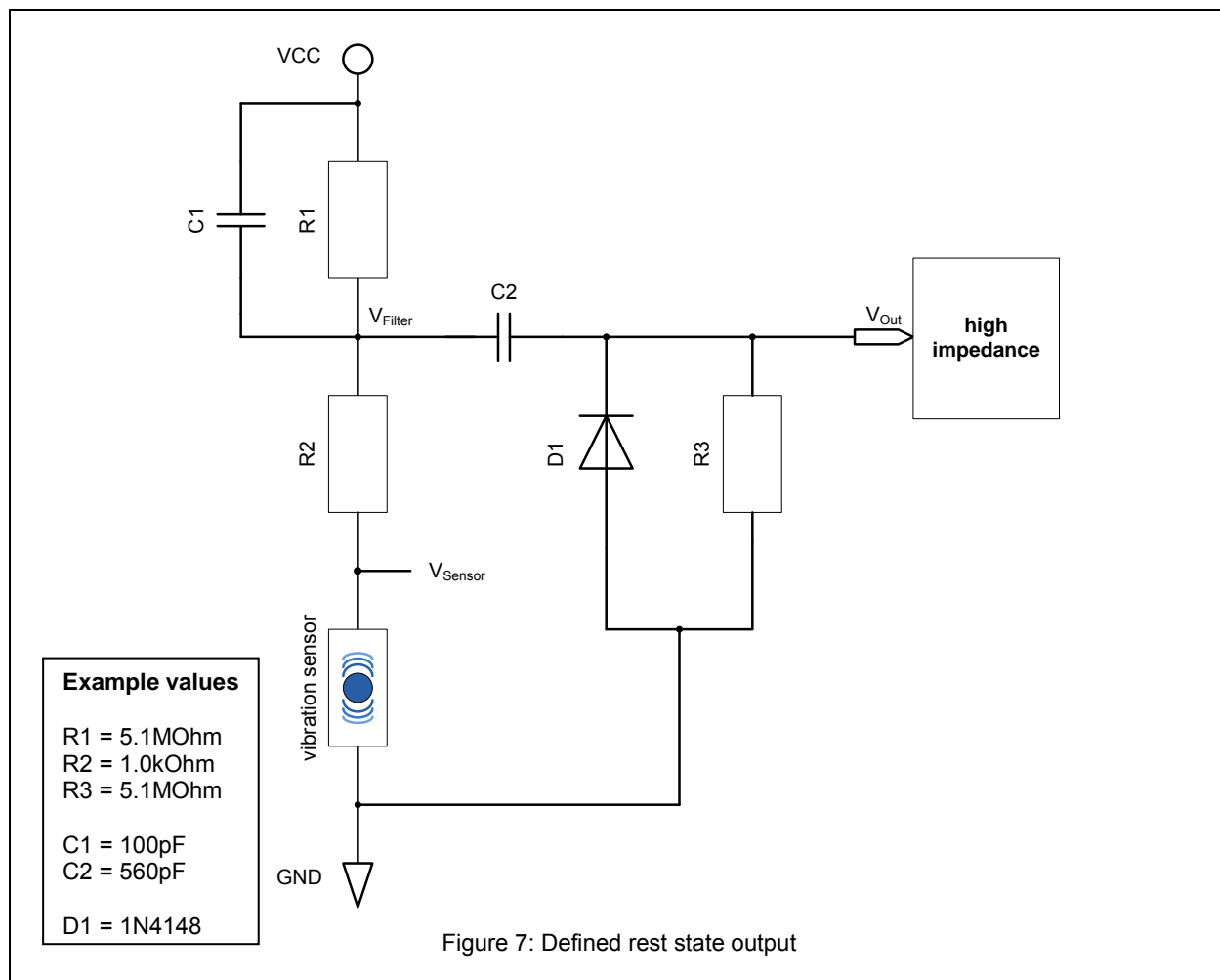
6.1 General description

Both versions of the micro vibration sensor (unidirectional MVS1006.01 and omnidirectional MVS0608.02/MVS0409.02) are not necessarily closed when at rest. Only in 70% - 99% of time they will be closed when at rest.
This circuit can be used, if the output signal needs to be **low** when the sensor is at rest (see Figure 8).

For low power applications high values of R1 and R2 can be used to further limit the current, however the circuit impedance must be considered. Depending on the desired output voltage swing resistor values of 5.1M R1 and 1.0k R2 can be used.
The capacitive voltage divider determines the filter characteristics. C2 should be ≥ 5C1. A value of 100pF for C1 keeps the high sensitivity of the sensor. A large C1 value e.g. 100nF will turn the peaks of the output into an analog average value.

6.2 Circuit

Figure 7: Defined rest state output

Figure 8: Function diagrams (idealized plot)
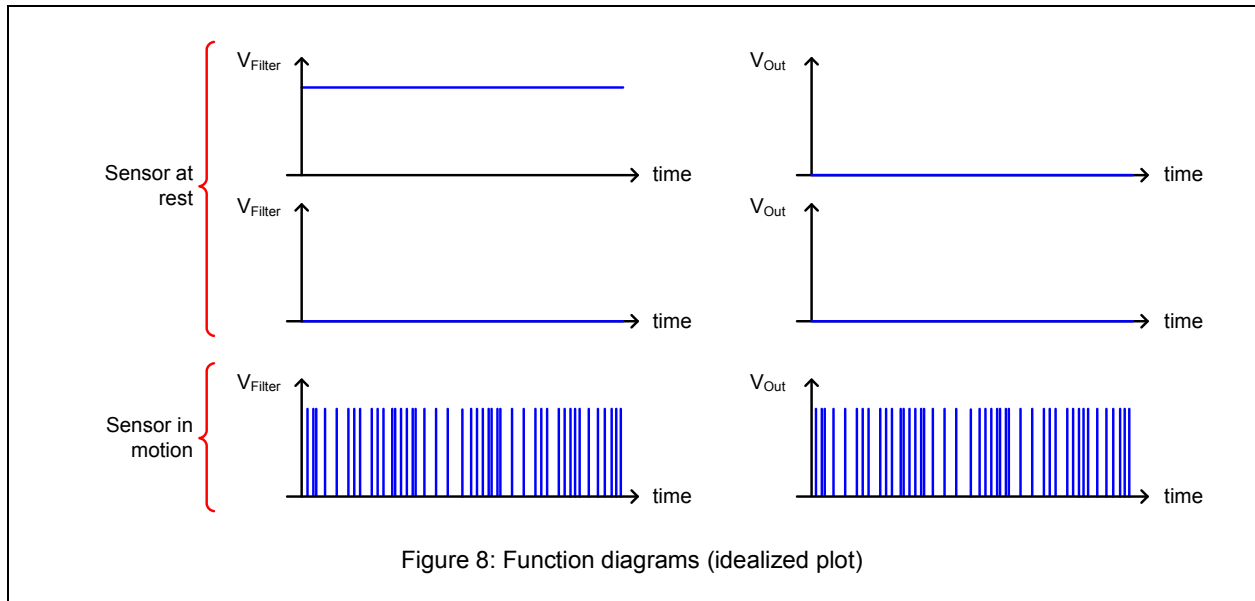
7. Delay circuit

7.1 General description

This circuit can be used, if the output signal needs to be **noise insensitive**, and **high** when the sensor is at rest (see Figure 10).
To increase the noise insensitivity, change the value of C2 in a range of 220nF – 4.7µF (for values ≥1µF use tantal capacitors).
An increase of C2 increases the inactivity of the circuit. Therefore a longer excitation is required to reach the threshold voltages!
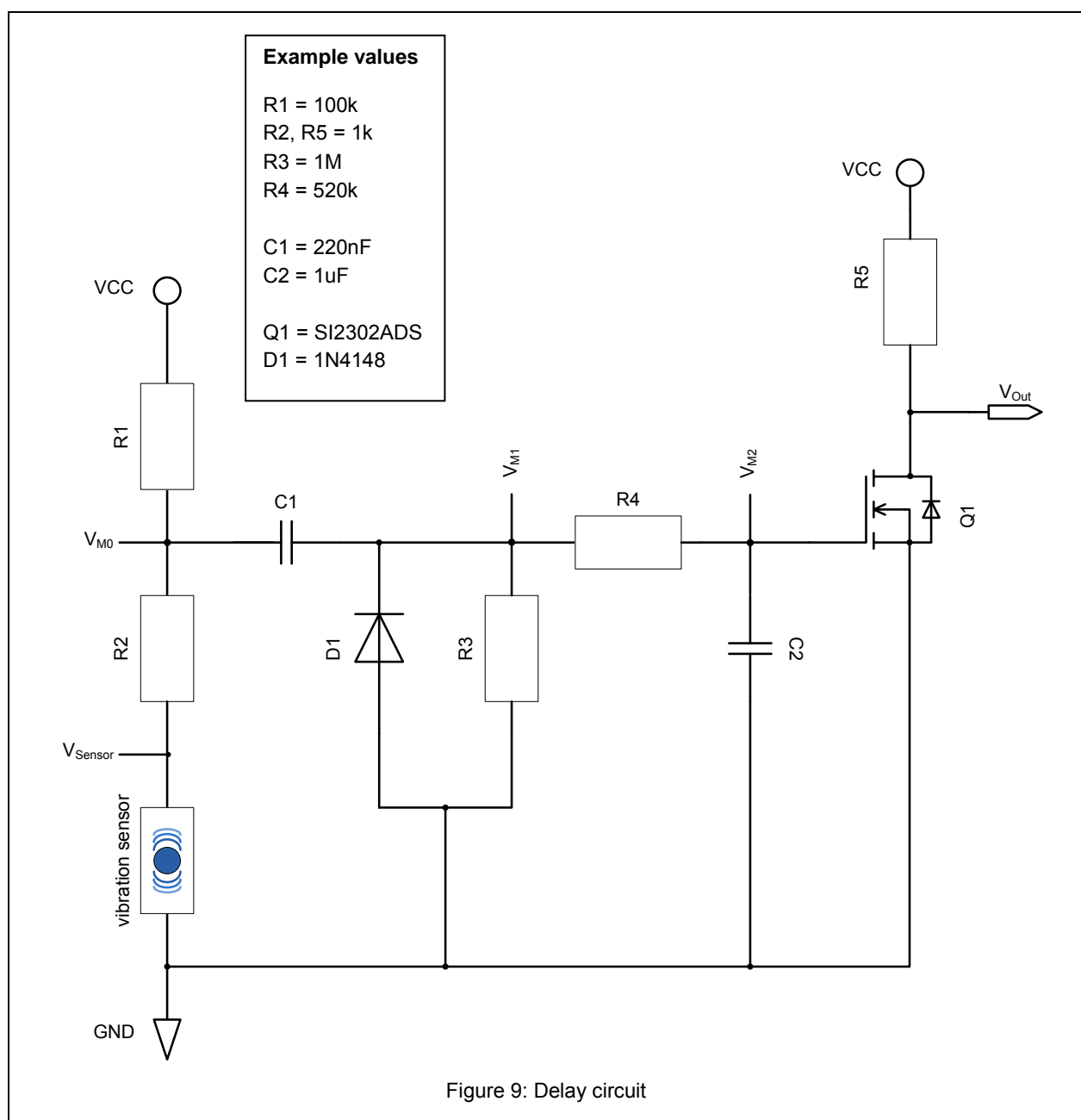
7.2 Circuit

Example values

R1 = 100k
R2, R5 = 1k
R3 = 1M
R4 = 520k

C1 = 220nF
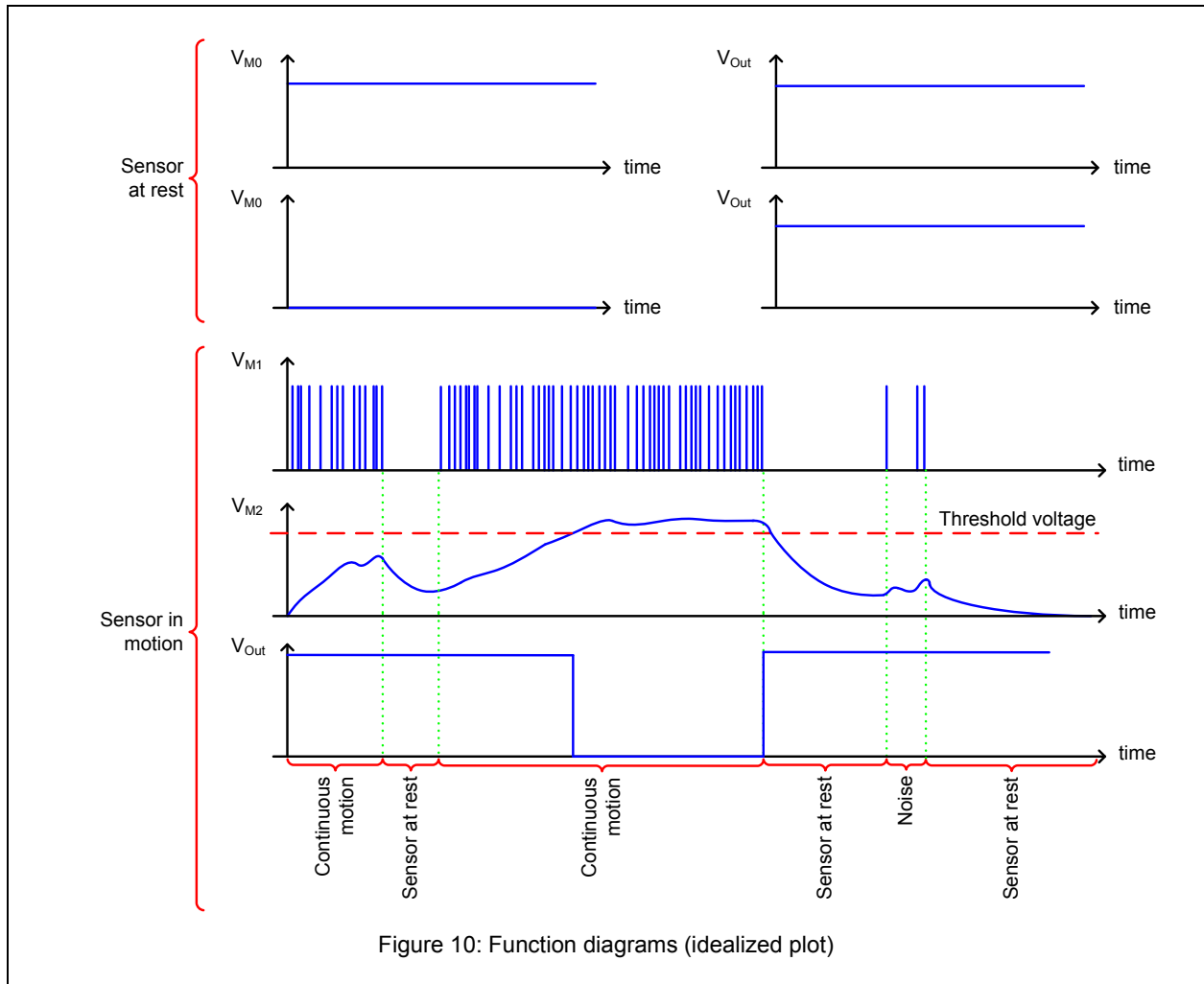C2 = 1uF

Q1 = SI2302ADS
D1 = 1N4148

Figure 9: Delay circuit

Figure 10: Function diagrams (idealized plot)

8. Digital filter

8.1 General description

The micro vibration sensor is connected to a low power micro controller to activate consumer electronics systems while in motion. When the device comes to rest, it is powered down (or up) by the microcontroller after a short delay time. The whole system is able to enter an idle mode with a current consummation of less than 0.6µA, depending on the micro controller used.
The algorithms digitally filter the sensor signal and allow easy adjustment of triggering sensitivity of the sensor to the applications requirement. Furthermore the algorithms eliminate the effect of sensitivity differences from sensor to sensor that naturally occur.

8.2 Circuit

Example values

R1 = 5.1MOhm
R2 = 1.0kOhm

C1 = 100pF

Figure 11: Digital filter
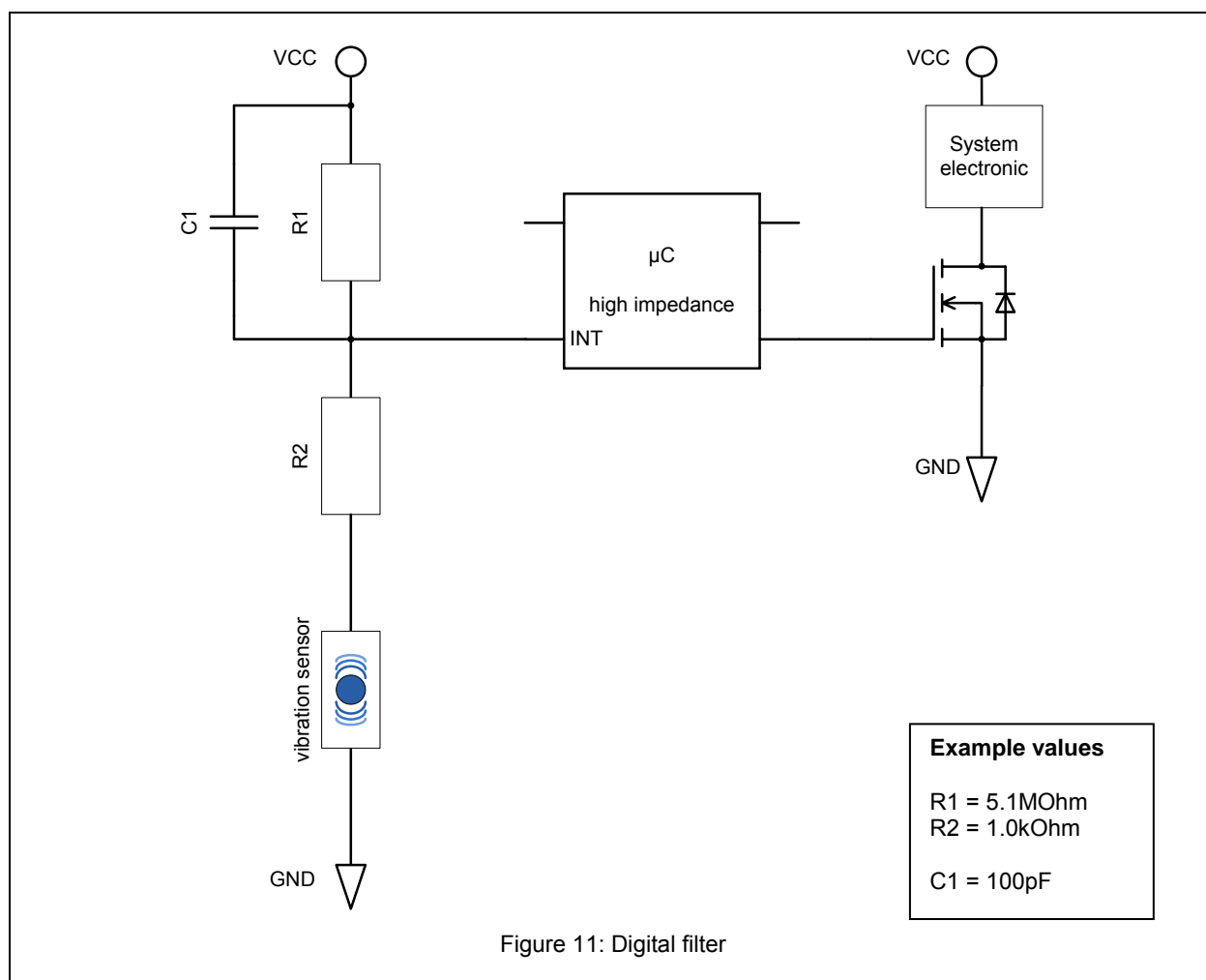
8.3   Schematic

The micro vibration sensor is connected in series with a 5.1 MOhm resistor, limiting the current running through the sensor. If the vibration sensor detects motion, a trigger signal is sent to the micro-controller and a timer delay will be started. Now it will be checked if there is a pulse in a time slot of e.g. 500ms. If there is no pulse the microcontroller is falling back into sleep mode after a short time. If there is a pulse after 500ms, check the following 500ms for a pulse etc. If threshold is reached, switch to a high power state or alarm. Vary the time and the amount of the time slots for different applications.

Figure 12: Function diagrams (idealized plot)
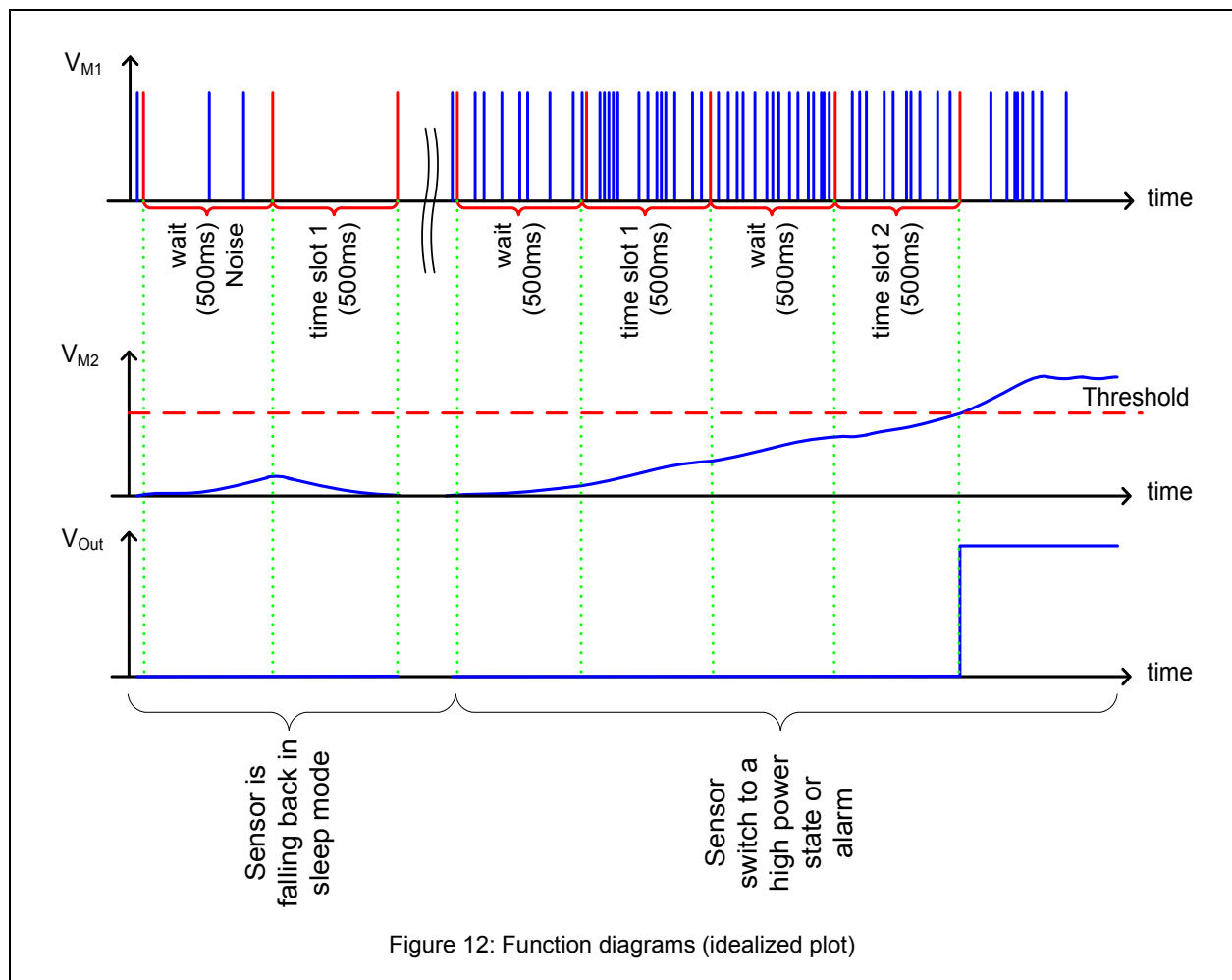
8.4   Implementation

- Timer: Generating a timer of e.g. 500ms.
- Input: Vibration sensor connected to an interrupt pin of the microcontroller to trigger an edge while in sleep mode.
- On interrupt signal: Disable further ext. interrupts.
- On time slot: Check for further pulse in a time slot of 500ms. If pulse detected, increment pulse counter variable by 3. Every 500ms, decrement pulse counter variable by 1 to decrease the value over time.
- Theshold: If the predefined pulse counter reach the threshold of 4 (4*500ms = 2 seconds of motion), switch to a high power state or alarm.

Definitions and program

- pulse_counter = 0   counter variable
- inc_value = 3   constant value to be added when motion detection in time slot
- dec_value = 1   constant value to be substracted if no motion is detected
- max_counter = 8   constant value to prevent overflow
- threshold = 4   constant value to switch to a high power state or alarm
       4 corresponds 2 seconds
- Initialize sleep_counter = 0
- Initialize pulse_detected = FALSE
- Initialize alarm = FALSE
- Initialize sleep_max_counter = threshold * 2

On interrupt signal

- Disable further ext. interrupts   // first impulse detected
- Timer delay of e.g. 500ms   // wait 500ms before checking for pulses

Do every 500ms

- Check for pulses in a time slot of e.g. 500ms   // check for further pulses
- If pulse_detected == TRUE
       If pulse_counter < (max_counter – inc_value) // check for possible overflow
       pulse_counter = pulse_counter + inc_value   // increment pulse counter
- If pulse_counter > dec_value   // check for possible underflow
       pulse_counter = pulse_counter - dec_value   // decrement pulse counter
- If pulse_counter >= threshold
       alarm = TRUE
       sleep_counter = 0
- Else
       alarm = FLASE
       sleep_counter = sleep_counter + 1   //increment shutdown counter
- If alarm == TRUE
       Alarm   // switch to a high power state or alarm
- If sleep_counter == sleep_max_counter
       Enable ext. interrupts
       Power down microcontroller   // for max power saving

9. MOSFET Circuit

9.1   General description

To reduce the floating of the output please use the circuit below, by decoupling with a MOSFET, the situation is defused. Please note, when measuring with an oscilloscope, it is recommended to use the 10x probe for circuit debugging.

9.2   Circuit

VCC = 3.0V
R1 = R3 = 5.1MOhm
R2 = 1.0kOhm

C1 = 100pF

Q1, Q2 = (e.g. NTR4003)

Figure 13: MOSFET Circuit
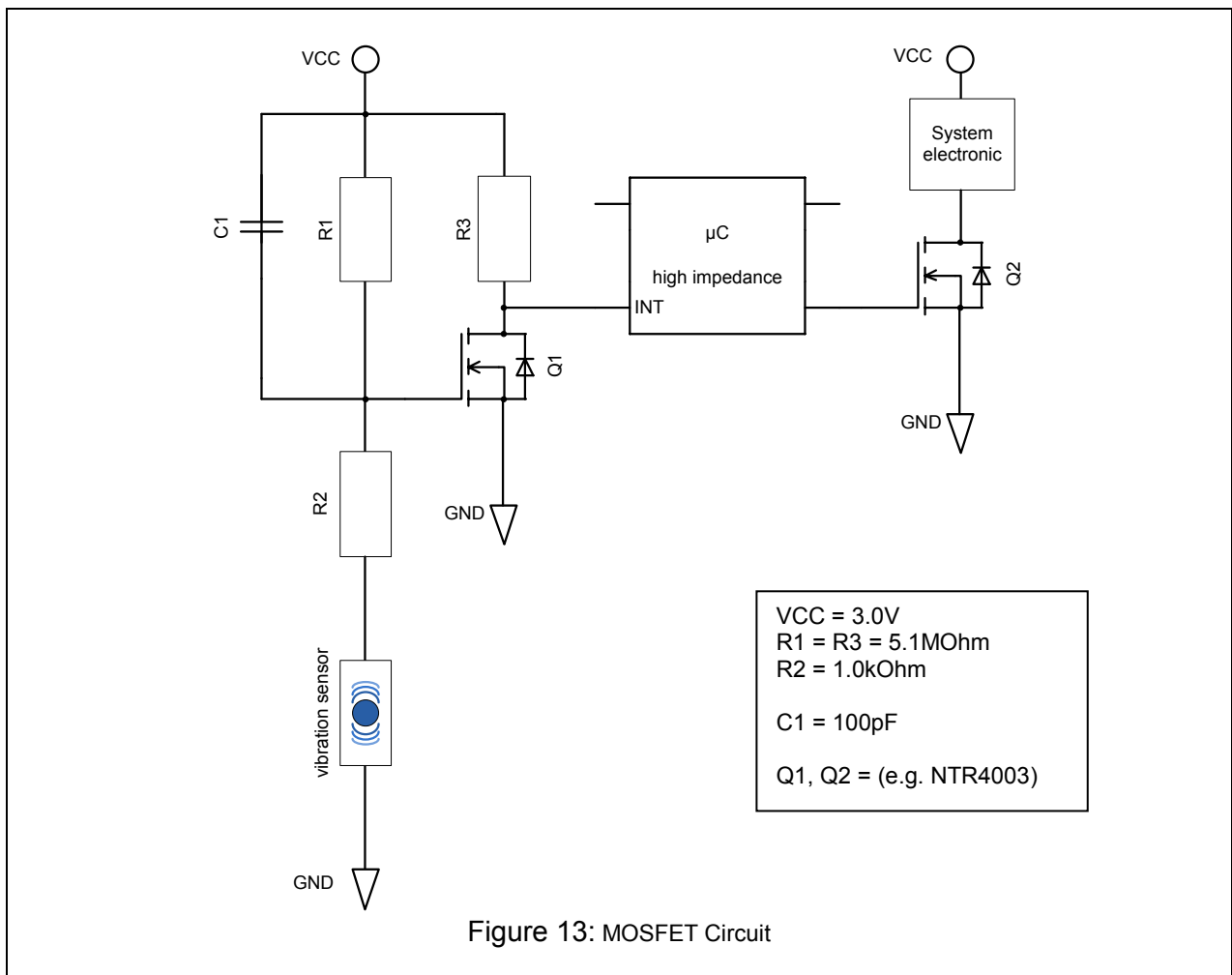
NOTES:

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