Automotive Technology

VE/TI Lab

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

Experiment 5

Name	NADZIRAH BINTI BACHO
Group Number	
Date	

5. High Side Switch

In this experiment, you will design a control circuit for a seat heating that works by a pulse width modulated voltage. As seen in the previous experiment, you will put the LIN keypad into operation and use it for controlling the seat heating.

The experiment is divided into two parts. The first part deals with the hardware setup of the heating resistor's control, as well as with the connection to the VN8950 interface. This part will completely be shown in a video. In the second part, you will put the button for the seat heating into operation, using CANoe.

Hardware and software design for a seat heating's control

Figure 1 shows the control circuit of the heating resistor as well as the VN8900 that you already know. Please search for information concerning the power switch used here, as well as for the operation amplifier.

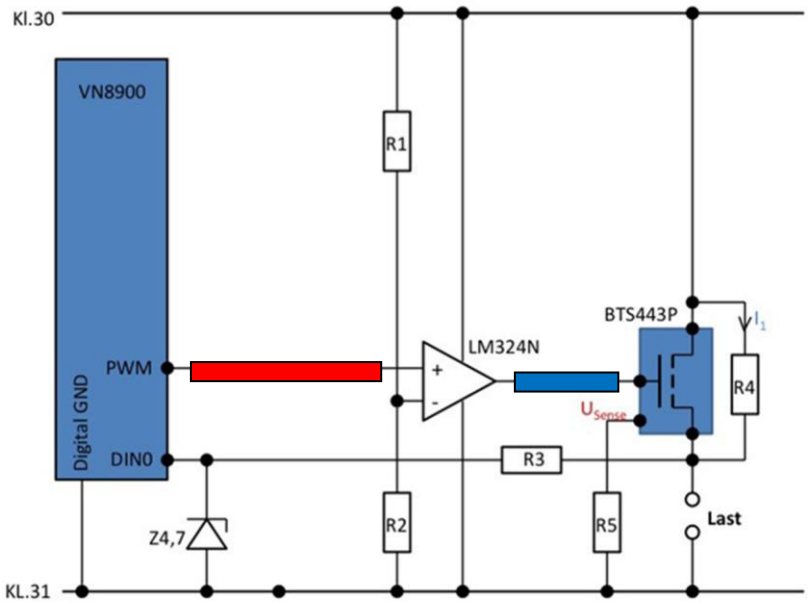

Figure 1: Electric circuit of the seat heating's control

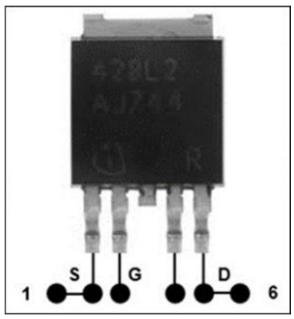

Figure 2: PIN assignment of the power switch (Infineon BTS443)

5.1. Introduction

5.1.1. General questions concerning the circuit

a) What is the basic circuit this operation amplifier is integrated in?

An operational amplifier is basically a three-terminal device which consists of two high impedance inputs. One of the inputs is called the inverting input, marked with a negative or 'minus' sign (-).

b) Describe its function in the operation amplifier circuit used here:

- Enable substantial amplification of an input signal
- Enables elimination of noise from an input signal

c) What is the dividing ratio between R1 and R2 that you should achieve here?

To stabilize the voltage in the circuit

d) Please highlight (in colours) the different voltage levels in figure 1.

e) What is the function of the Zener diode in the circuit?

Zener diodes are used for voltage regulation, as reference elements, surge suppressors, and in switching applications and clippers circuits. The load voltage equals breakdown voltage VZ of the diode. The series resistor limits the current through the diode and drops the excess voltage when the diode is conducting.

f) What is the function of the high side power switch (BTS443P) in the circuit?

High side power switch with integrated vertical power FET, providing embedded protection and diagnostic functions.

g) On pin no. 4 of the high side power switch, R5 is connected to ground. What is the functionality provided by the output?

To disconnect the power source from a load

h) Please specify the calculation formula for $R5 = f(V_{bb}, I_{Last}, K)$ referring to figure 1.

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i) Two heating resistors are used as load. Please sketch three different setups for the resistors (parallel, …) for reaching a variation in power. Afterwards, calculate P_{ab} of the different setups.

Figure 3: component carrier with two heating resistors

5.1.2. Determining the circuit's specific values

j) R1, R2

Determine the resistors R1 and R2 of the operation amplifier circuit and select appropriate values out of the E12 range.

R1:_____Ω; R2:_____Ω

k) R3, R4

R3 and R4 are used as current limitation for the VN8950. The maximum permitted in terms of current (I1) is 0.365 mA. Determine the values for R3 and R4. Consider that both of them should have the same electric conductance.

l) R5

Determine the value for R5 by means of the correct calculation formula. The following values are given:
$R_{Last,\ max}$ = 9 Ω, K = 5100
Specify the following values: $I_{Last,max}$, I_{sense}, U_{sense}

R5:_____Ω

5.2. Diagnostic function

The input DIN0 (digital IN 0) of the VN8950 is used as diagnostic function of the circuit. What is the level the input DIN0 would have for the following cases, considering the power switch activated:

a) Open load
b) Short circuit

5.3. Hardware setup and control on the breadboard

Please refer to the video showing the hardware setup!

5.4. Function development with VN8950 interface

After realizing the hardware setup of the seat heating, we want to put into operation another button on the LIN keypad in this last experiment, and more precisely, the button activating that is meant to activate the seat heating. Please reuse your previous configuration of the CAN/LIN gateway. (If you are using the demo version and it did not save correctly all the previous data, just add the missing nodes/databases of the CAN/LIN network).

5.4.1. Putting into operation the seat heating button

Reading the state of the seat heating button and the control of the corresponding LED is realized in the same way as you did with the hazard light button.
Besides the case of the hazard lights button, the keypad is in a state able to operate only if the signal *ISw_Stat* has the value *ON* when starting the measurement.

- Look for the corresponding signal in the database and activate the keypad by the correct signal value.
- Open the CAPL code of the keypad and activate the keypad when starting the measurement.
- The seat heating buttons are addressed by the signals *SeatHt_FR_Pos_Rq* and *SeatHt_FL_Pos_Rq* for the right and for the left. The LED state can be specified by using the signals *SeatHt_FR_Stat* and *SeatHt_FL_Stat*. Once again, look for the corresponding signals in the database and set the LED's by using the correct state value.
- As far as its behaviour is concerned: When pushing the button one time, all the three LED's of the seat heating button should light up. When continuing to push the button, all the LED's should light up one after the other. If there are no LED's left activated, the same reaction should start again. Decide whether you want to use the driver's side or the passenger's side and realize the function in CAPL.

5.4.2. Generating the PWM and the output on the port

Besides the four bus channels (CAN, LIN), the Vector hardware VN8950 is equipped with an analog/digital port (D-Sub 15).
The high side switch should be controlled by a pulse width modulated voltage by the software, using the digital output of the VN8950.
For putting into operation the I/O port of the VN8950, the interface has to be activated first. You have to select the mode standard in CANoe: when clicking on Hardware -> Vector I/O, a corresponding window will open (see figure 4). In addition, you can display the predefined PIN assignment of the I/O ports in the same window.

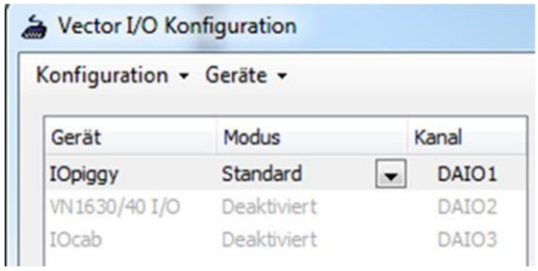

Figure 4: Activating the VN8950 I/O Piggies

- What is the pin assignment for using the PWM of the I/O piggies?

Label	Pin

- By clicking on the menu item *Configuration -> system variables*, you can access the I/O ports in the name space IO.

- On the output side of the adapter, the seat heating (operation amplifier) should be connected, as you have seen in the video. By controlling via a PWM signal, different heating capacities should be reached. Please consider the logical switching states of the high side switch (logical 0: the switch should be activated)

Anzahl der LEDs	Heizleistung
0	0%
1	30%
2	60%
3	100%

- How can you implement such a behaviour in principle?

- **Implement this behaviour, then check and upload all your code data so that it can be tested, as well as all the other functionalities you already set into operation.**