

PCB Design for Capacitance Rain Sensor

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EXECUTIVE SUMMARY

The definition of sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Many different purposes of sensors currently exist in the world market and our capacitive rain sensor has a purpose to detect rain drop on a vehicle windshield. To detect a rain drop, our team used many different parts and needed to integrate in the Printed Circuit Board (PCB). And this created PCB will send the signal to microcontroller.

Key word

PCB design, Capacitance to Digital Converter chip (AD7745), Voltage Regulator (AD3301), Trace design.

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1. Object

The purpose of this application note is to introduce our PCB layout, configuration, and explain briefly about the components which are used in the PCB.

2. Introduction

Our sponsor, Hyundai Motor, wanted us to develop a Capacitive Rain Sensor to replace the current Optical Rain Sensor. Hyundai Motors has size, price, and detecting levels requirements. Our team researched and found the right components and design of sensor traces for our project. And we need to integrate this detecting trace and microchips in the PCB to make possible to communicate with microcontroller. On the PCB board, we select AD4457 for Capacitance to Digital Converter (CtD), AD3301 for voltage regulator, and sensor trace is attached corresponding pins of microchips.

3. Components

1. Sensor Trace

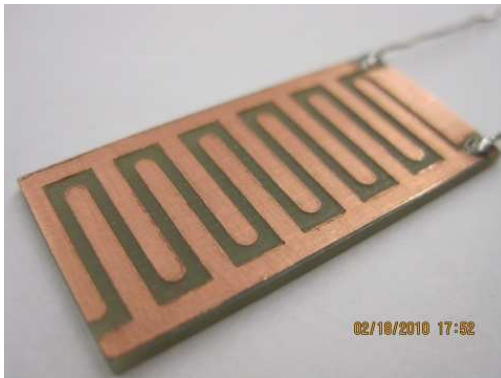


Figure1. Sensor Trace

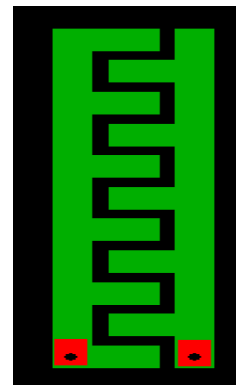


Figure2. Sensor Trace Design w/ software

Trace use fringe field to detect water. We used COMSOL software to develop trace design which generates maximum fringe field. Two corners (red dots in the figure 2) of the trace are connected to the CtD converter, and it sends a signal when trace

detect water

2. Capacitance to Digital Converter, AD7745



Fig3. AD7745 chip

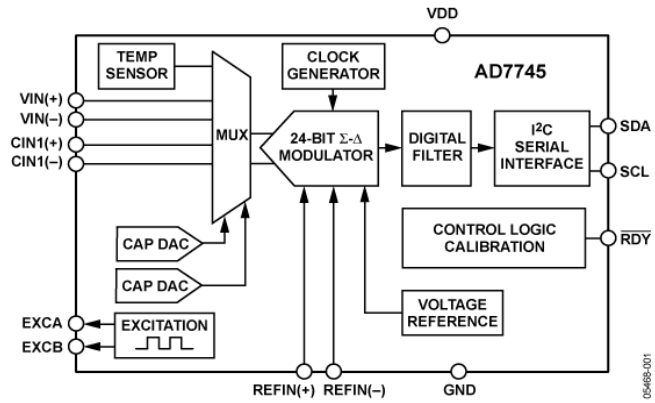


Fig4. AD7745 Block Diagram

The AD 7745 is a high resolution CtD converter. The capacitance to be measured is connected directly to the device inputs (trace). The AD7745 has one capacitance input channel. It is compatible with I²C serial interface and can operate with a single power supply from 2.7 volts to 5.25 volts.

6 pins are used out of 16 pins. GND is connected to ground. EXCA and CIN1+ are connected with the sensor trace, and SCL and SDA are connected to the microcontroller interface. And VDD is connected with output of the voltage regulator AD3301 (See Fig6).

3. Voltage Regulator, AD3301

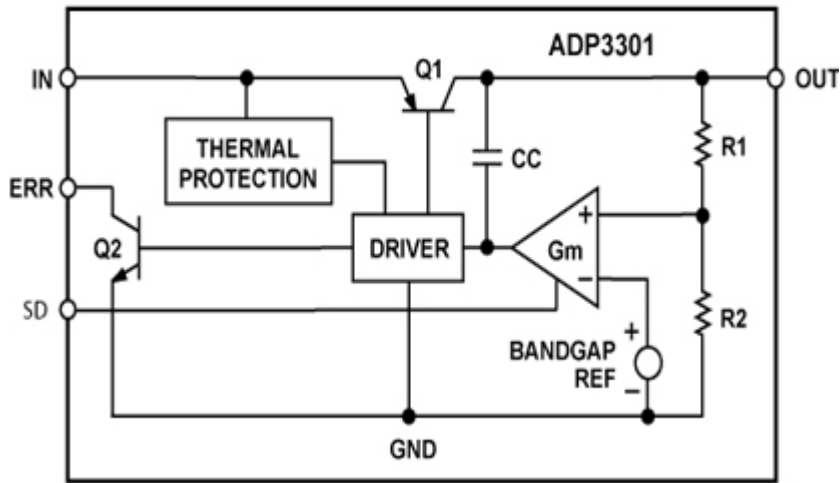


Fig5. AD3301 Block Diagram

The CtD converter, AD7745, operates between 2.7 volts and 5.25 volts. However, most vehicles use a 12 volt battery. Due to the voltage, we had to drop battery voltage down to an operational voltage level. The AD3301 can drop the voltage. The AD3301 operates with wider input voltage range from 3 volts to 12 volts and delivers a load current in excess of 100mA. And it is able to drop voltage to our operation level which is 5 volts. It features an error flag that signals when the device is about to lose regulation, short circuit, or thermal overload protection is activated. IN is connected to voltage source, GND is connected to ground, OUT is connected with VDD of AD7745 – and SD is connected to microcontroller.

4. PCB Schematic and Layout

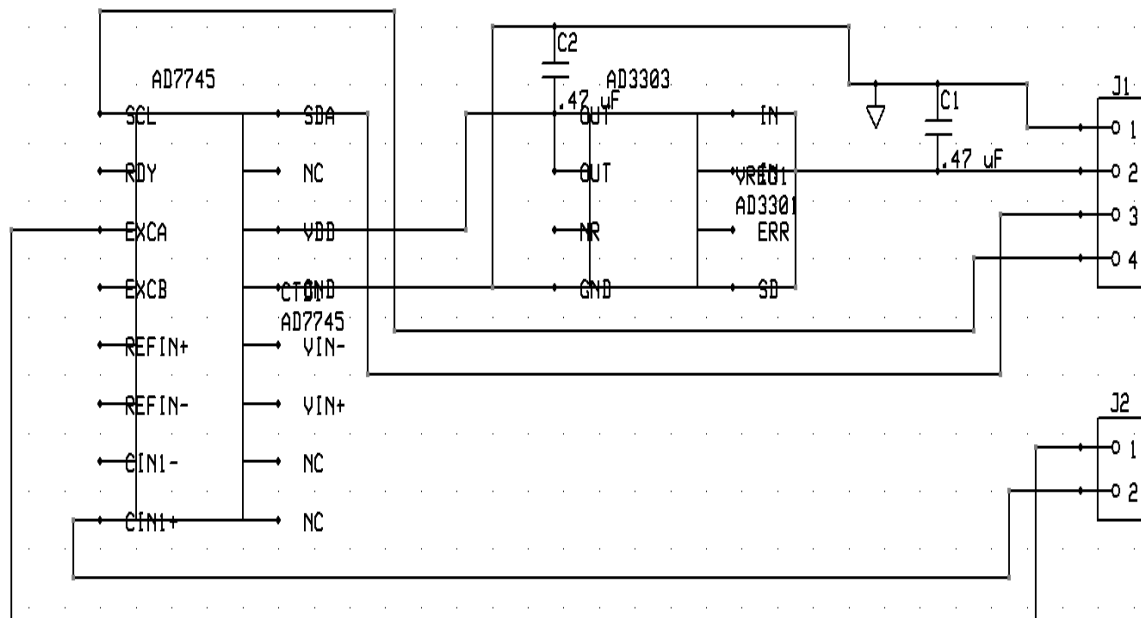


Fig6. PCB schematic

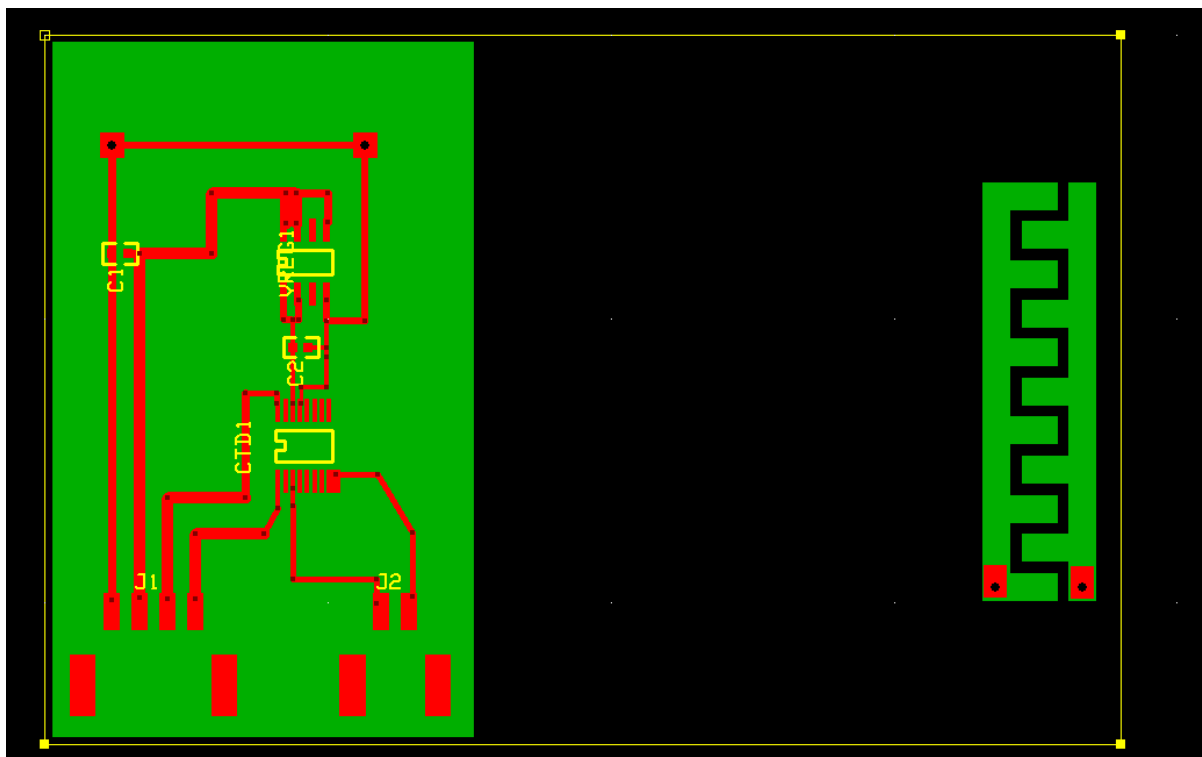


Fig7. PCB Layout and Sensor Trace

5. Conclusion

We designed a qualified PCB in size, functions, and price. However, our PCB design focuses on concept proving. Hyundai Motor has better testing environment, therefore, Hyundai Motor may be able to improve from our initial design. They can obtain more accurate result from their testing. And they also can use vehicle Body Control Module. It can replace the microcontroller. Then, they can directly connect to the wiper system and test for mass production. It also helps reduce size and price. And if they order and fabricate in bulks, it will reduce cost significantly.