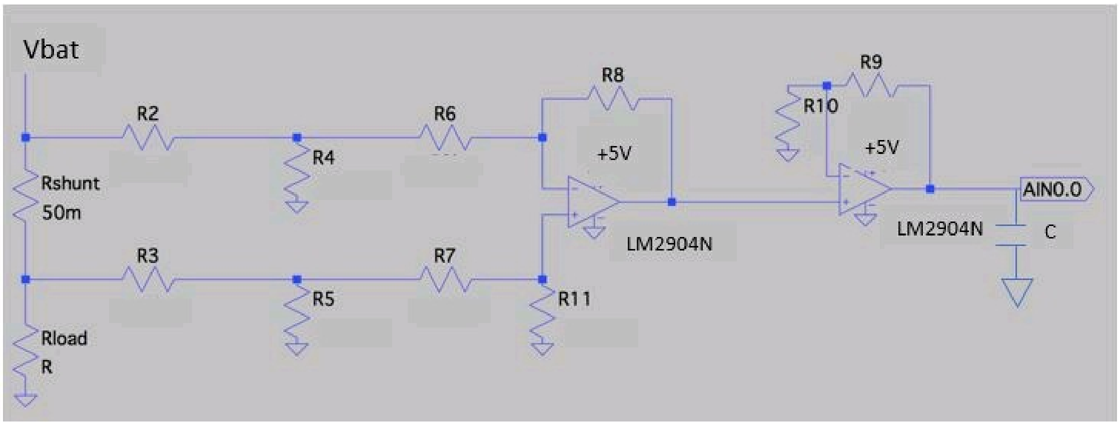
09_Current Sensors

A) Introduction

In this part, we are going to explain how can we design a hardware current sensor to know the current and the energy. To get all the value of each current sensor, refer to the PCB board !

B) Hardware part



As we can see on this circuit, we have different part :

Shunt resistor of 50 mOhm

Half bridge

AO subtractor

AO no inverser

First step

The unknown variable is the current through the Shunt resistor. This resistor is placed between the power supply and all the load of the circuit. First we should find the worst case of our circuit, in other word we have to find the maximum current which can circulate through the load.

When everything is connected we found a current of about 1.5 A

Second step

The next step is to transform a differential voltage (from the Shunt) to an unipolar voltage (Output of the AO subtractor) We can't connect the 2 potentials to the AO directly because we have to take care of his common mode voltage !

Here, we have an AO LM2904N with a common mode voltage of : Vcc - 1.5 = 5 - 1.5 = 3.5 V

So we have to calibrate correctly the half bridge for having an output voltage of maximum 3.5 V

Moreover for the AO subtractor, we have a gain of 1 because we don't want to amplify here. That's why I put an AO no inverser in the end.

But, we should to have a look on all the impedance of each part. The output impedance of the half brigde should be "small" compared to the input impedance of the AO subtractor [Zin = 100*Zout]

Third step

Finally, we can add an AO no inverser to amplify the unipolar voltage to the common mode of this AO (3.5 V). This voltage will be sent to the ADC of the AURIX™ and it should be under 5V (This is the maximum of voltage admissible by the I/O of the AURIX™). We add a capacitor to smooth the output signal because when the motors are activated we have some oscillations !

C >= 1/[delta_u*f]

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delta_u : voltage oscillation of the signal
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f : oscillation frequency

C) Software part

Following the figure below, we can determinate both formulas :

$$I = \frac{V_{AN0}}{R_{Shunt} \cdot \left(1 + \frac{R_9}{R_{10}}\right) \cdot \left(\frac{R_4}{R_2 + R_4}\right)} \; [en\ A]$$

$$E = Vbat.\,I.\,t_{timer} \; [en\ W.h]$$

Regarding the ADC, we used the Versatile Analog-to-Digital Converter of the AURIX™. In order to implement it, we just looked at the demo code given with the "Low Level Drivers" (iLLD).