Faculty of Exact Sciences and Engineering

Digital Systems - Project (2nd phase) -

Digital scale

Trabalho realizado por:

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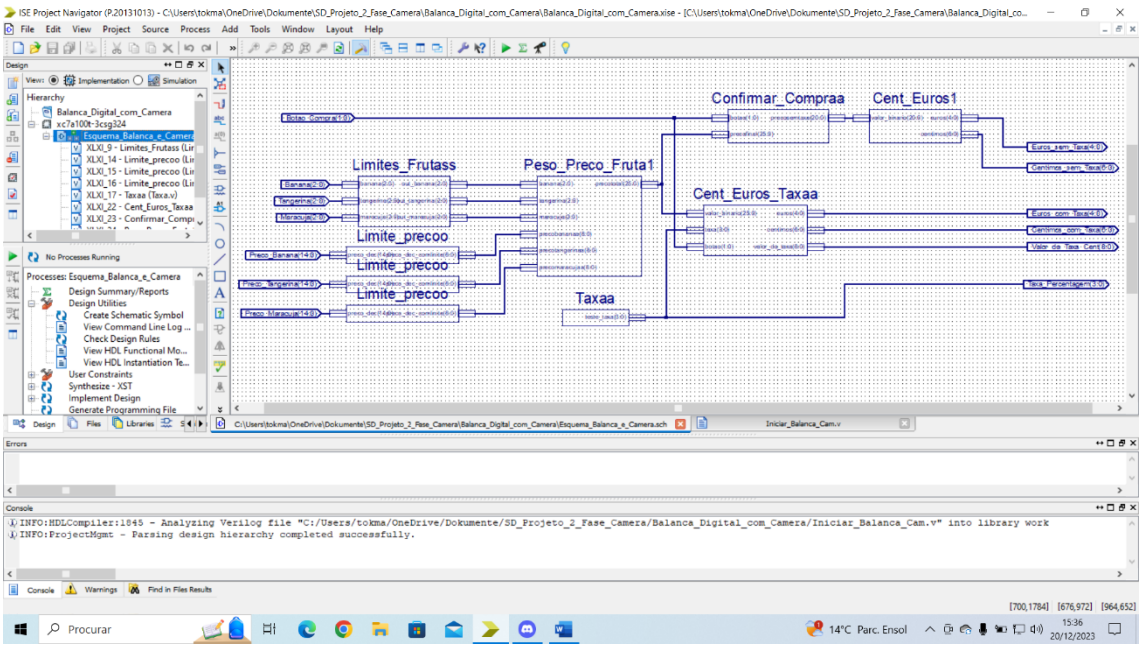
➢ Introduction

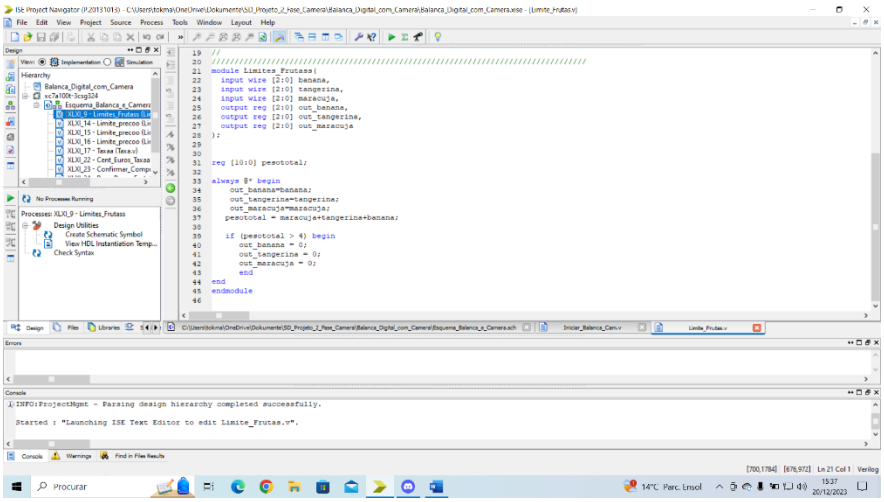
The central objective of this project is to develop an advanced digital scale, equipped with the ability to recognize and specifically weigh three regional products: banana, passion fruit and tangerine. This innovation arises from the need of a regional company to optimize the composition of baskets of fresh products with a total weight of up to 2000g, with each package weighing 500g. The price for each package has a maximum of €5 which is equivalent to 500 cents.

The integration of a camera module into the scale is our biggest challenge, allowing precise identification of products and automatic price calculation, including an additional fee that corresponds in percentage to 3 times the result of the remainder of the entire division by 9 of the sum of the digits of the number of the oldest student in the group (2131023), which in this case gave a rate of 9.

✓ Schematic of the scale with the camera module

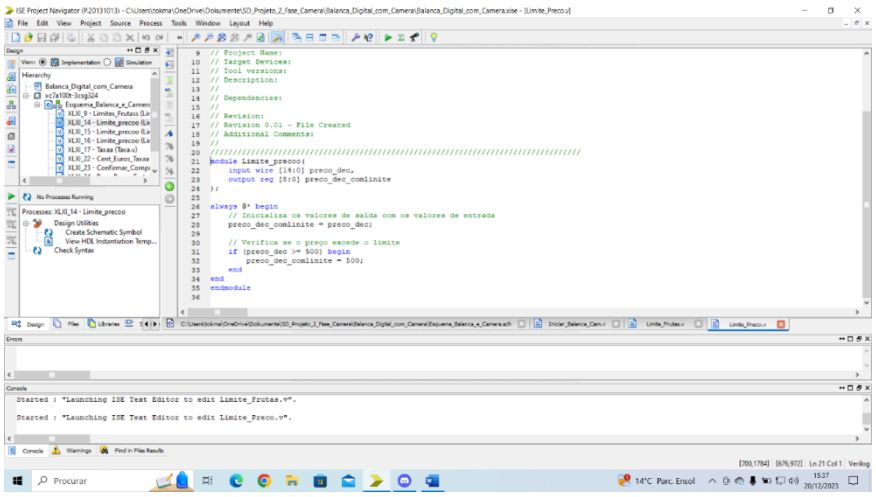


✓ Fruit Limits



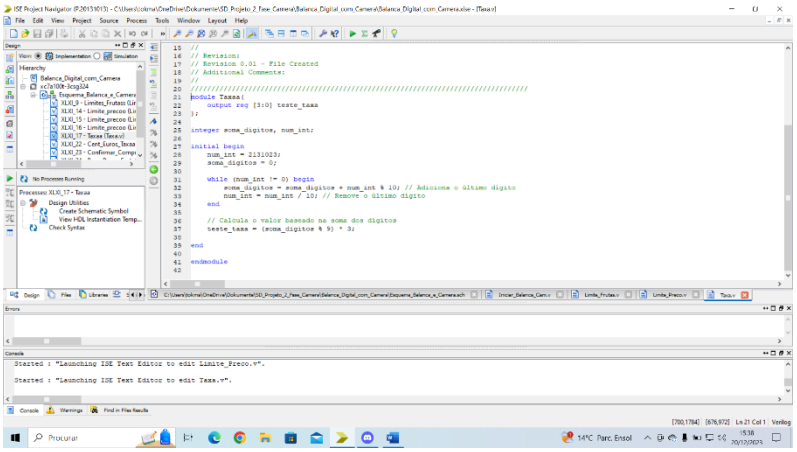
- In this module we check that the quantity of fruit does not exceed the limit of 4 products (packaging + fruit) which would give a maximum of 2000 grams.
- This Verilog module processes the weights of the 3 fruits: banana, tangerine and passion fruit. It receives the weights as inputs (each with 3 bits) and provides the processed weights as outputs. The module calculates the total weight of the fruits and checks if it exceeds 4 units. If the total weight is greater than 4, the output weights of all fruits are zero, indicating an overload condition or exceeded limit.

✓ Price Limit



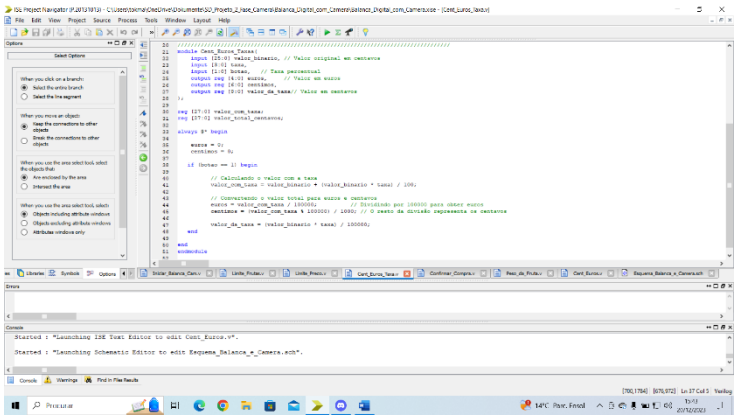
- This Verilog module processes the fruit prices, takes the price as input (with 15 bits) and gives the limited price as output (with 8 bits). The module checks if the price exceeds 500 cents, and if it exceeds the output at 500 cents. This module is repeated 3 times (banana, tangerine and passion fruit).

✓ Rate calculation

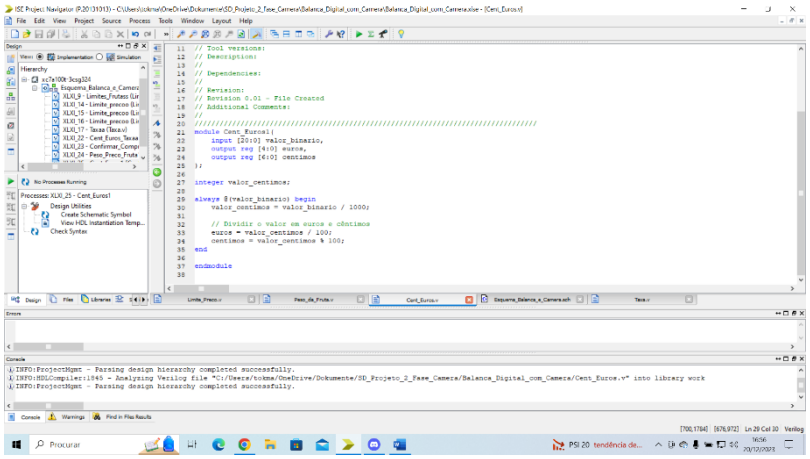


➢ The “Rate” module in Verilog calculates a value based on the sum of the digits of the number 2131023. It adds all the digits of that number, calculates the remainder of dividing this sum by 9 and multiplies the result by 3. The final value is stored in the output “test_rate”, which is a 4-bit register. The result of our rate is 9, the rate being 9%.

✓ Result in euros and cents with Rate

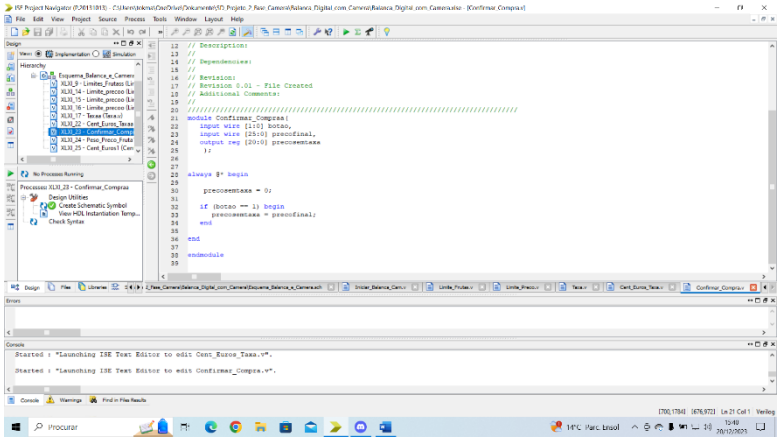


✓ Result in euros and cents without fee



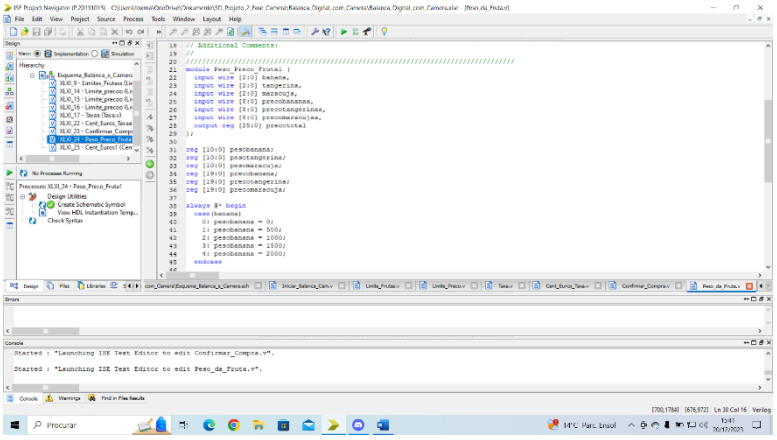
- The "Cent_Euros1" module in the Verilog converts the total value ("binary_value") into euros and cents. The input total value ("binary_value") is provided as a 21-bit number, and the conversion is done considering that each unit of this total value represents 0.001 cents. The module calculates the total value in cents by dividing the total value by 1000. Then, this value is divided into separate euros and cents: the value in euros is obtained by dividing the total cents by 100, while the value in cents is the remainder of this division.
- For example: The previous module that gave 2 000 000 / 1 000 = 2 000, which when divided by 100 = 20 euros and doing the rest of the division by 100 gives 0 cents.
- The "Cent_Euros_Taxaa" module is almost the same thing as "Cent_Euros1", what differs is that it already has the rate.

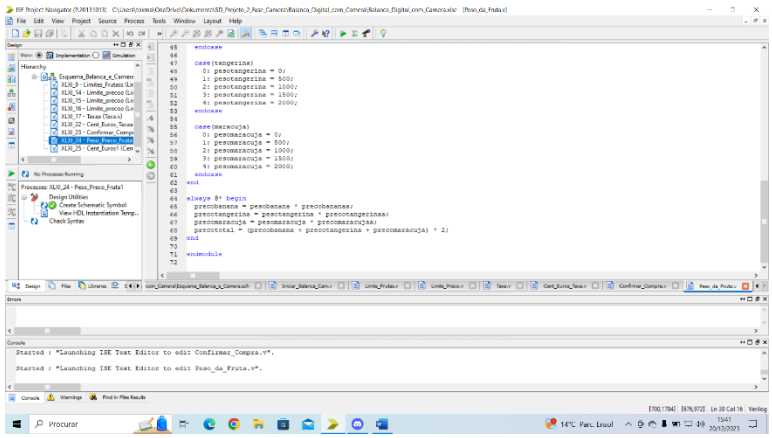
✓ Confirm Purchase

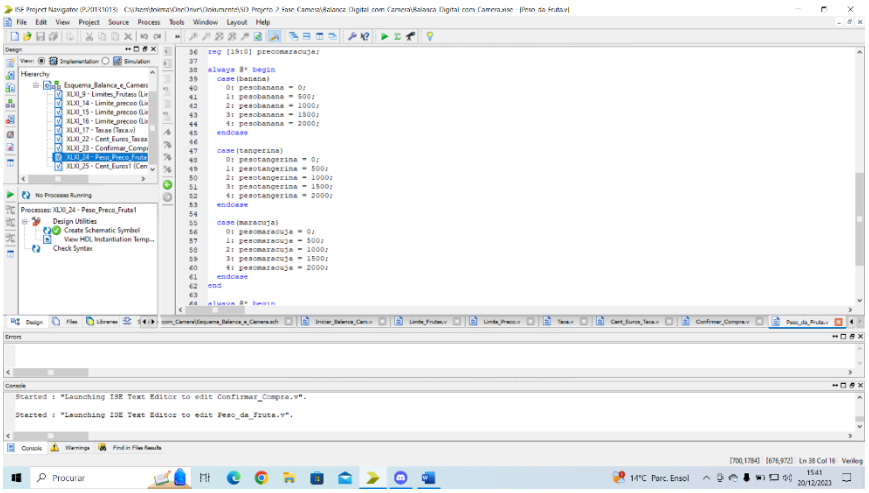


- In this module we check if the button was pressed. If the button has been pressed, the output value will be equal to the input value, if the button has not been pressed, the output value will be equal to 0.

✓ Calculation of Weight and Price



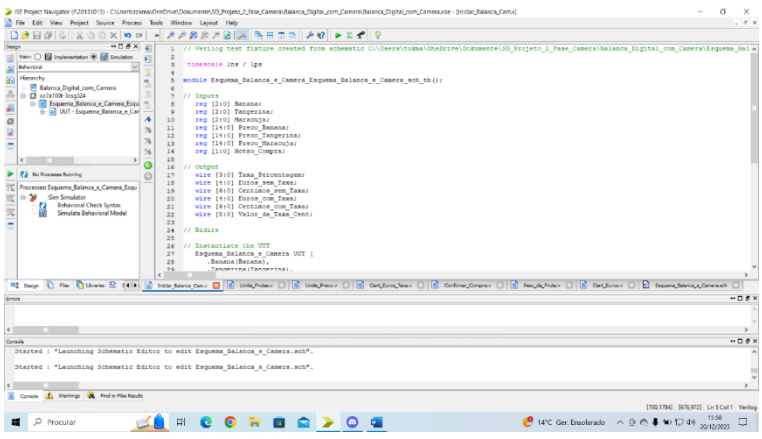


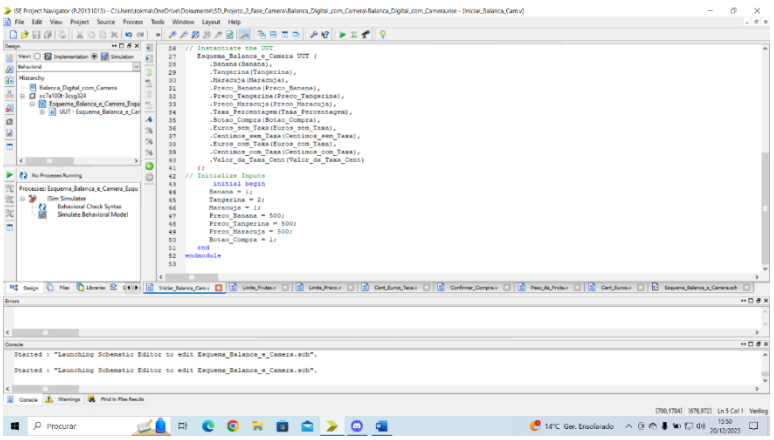


- In this module we calculate the price of products, using the quantity of products we calculate their weight and multiply by the price, after calculating the prices of each product we add them all up and multiply by 2 so that each unit is worth 0.001.

- **For example:** If the person puts 1 package of banana, 2 of tangerine and 1 of passion fruit and they all cost 500 cents per package (500 grams): (500 (weight) * 1 (product) * 500 (price)) + (500 * 2 * 500) + (500 * 1 * 500) = 1 000 000 * 2 = 2 000 000 (which changing to euros would be 20 and 0 cents).

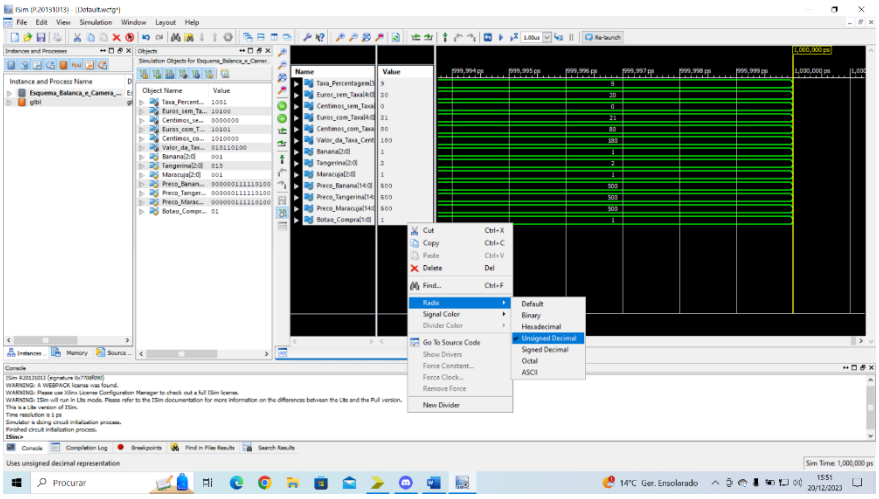
✓ Start the Scale by entering the Values (Inputs)





- In this module we enter the prices, quantities of products and the status of the button we want (inputs).

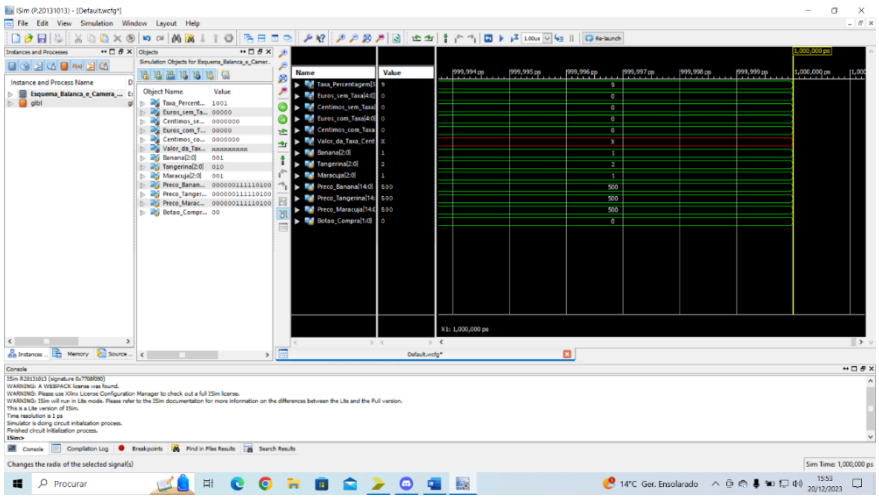
✓ Scale results with the button pressed



- When we leave the purchase button at 1, the Receipt comes out in the normal way showing the result of the price in euros and in cents with and without the rate applied, also showing the value of the rate applied in cents and the percentage of the rate.
- In this case we use 1 banana, 2 tangerines and 1 passion fruit, with prices of 500 cents each product (banana, tangerine and passion fruit) and by default 500 grams each product with the tare included.

- In this case the final price would be: 1 * 500 + 2 * 500 + 1 * 500 = 2000 cents, being 20 euros. As the rate is 9% then 2000 * 0.09 = 180 being 1 euro and 80 giving in the end 20 + 1.80 = 21.80 € with the rate applied.
- Fee value = 180 cents

✓ Scale results with the button without pressing it



- When we leave the purchase button at 0 (without pressing it), we see that the price result in euros and cents is 0 (as expected) and that the rate is intentionally incorrect.

➢ Conclusion

When we finished this project, we successfully achieved the initially proposed objectives. The developed digital scale demonstrated a remarkable ability to effectively identify and calculate the weight of products by efficiently integrating the camera module. The precision in weight calculation and final price calculation fully met the needs of the regional company, marking a significant advance in the basket formation process.

This system, in addition to improving operational efficiency, ushers in a new era in the regional product sales sector, illustrating how digital technology can innovate traditional commercial practices, paving the way for future innovations.