Time and power performance study on 8-bit microcontrollers

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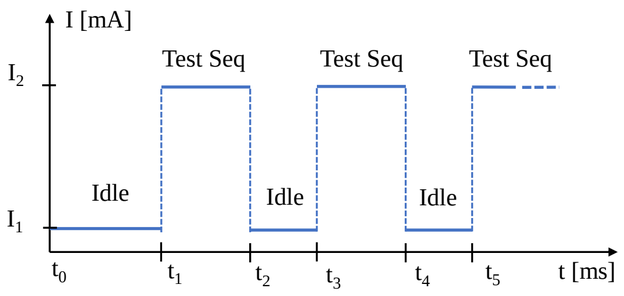
Introduction

Throughout the design cycle of a project based on an embedded system, the microcontroller's performance is always critical for the project's success. But what does performance represent for a microcontroller and how can we quantify it? This paper focuses on analyzing the microcontrollers' performance based on two characteristics: the execution time of a certain test sequence and the power consumption during the execution of the test sequence

Prerequisites

The general concept description for determining the time and the power performance is presented using the figure below. The figure shows a graphical representation of a succession of tasks, represented by the *Test Sequence* states (high core load) and *Idle* states (low core load). The performance evaluation of a microcontroller in this paper is presented as the amount of time needed to perform a certain task and the amount of additional current needed during the execution of that task.



General concept description

The formulas below describe the required execution time for a certain test sequence and the current consumption during the execution of a test sequence.

$$T_{test\_sequence} = t_2 - t_1$$

$$I_{test\_sequence} = I_2 - I_1$$

The test sequences are represented by the test algorithms that are carefully designed to reflect real life scenarios. In this paper four algorithms are explored:

- Idle algorithm
- Arithmetic algorithm
- Search Data Memory algorithm
- Search Program Memory algorithm

The tools used in the experiments are the following:

- *MikroC PRO for PIC IDE and compiler* – used for test program development
- *Aim TTi 1908 digital multimeter* – used for current consumption measurements
- *Tektronix DPO2002B oscilloscope* – used for execution time measurement

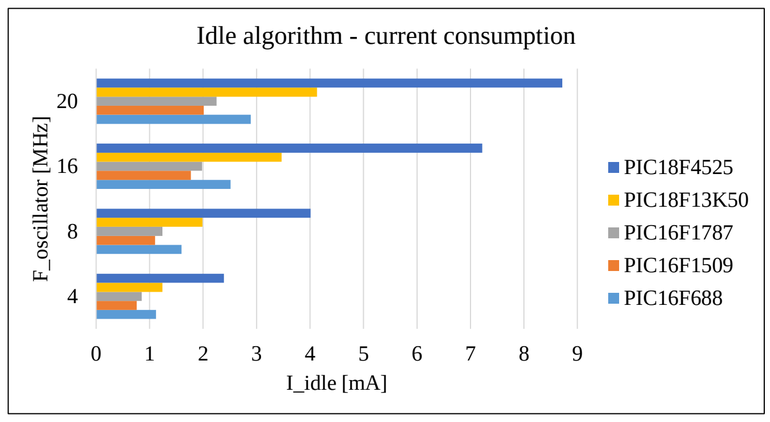
Experimental results – Execution time and Current consumption

The figure to the right presents the total average current consumption of the tested microcontroller in an *Idle* state.

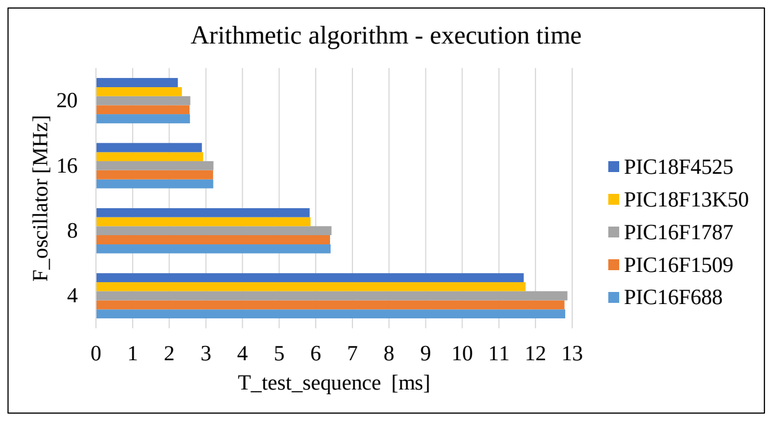
For each algorithm, there are two measured parameters:

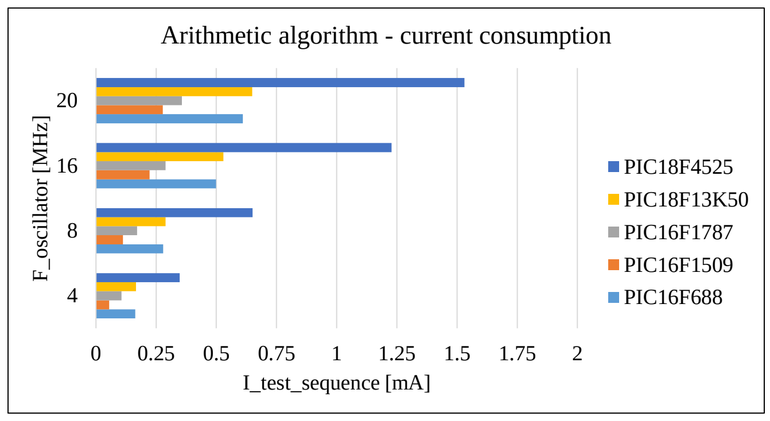
- the execution time of the algorithm;
- the average impact of the execution of the algorithm over the current consumption of the tested microcontroller;

Note that for all charts, lower is better.

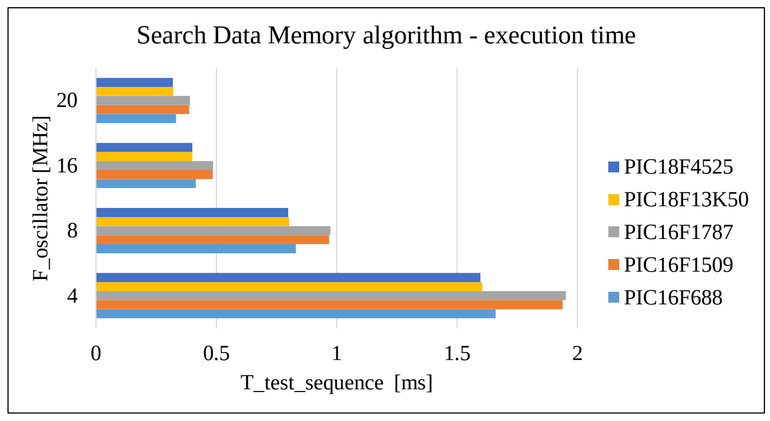


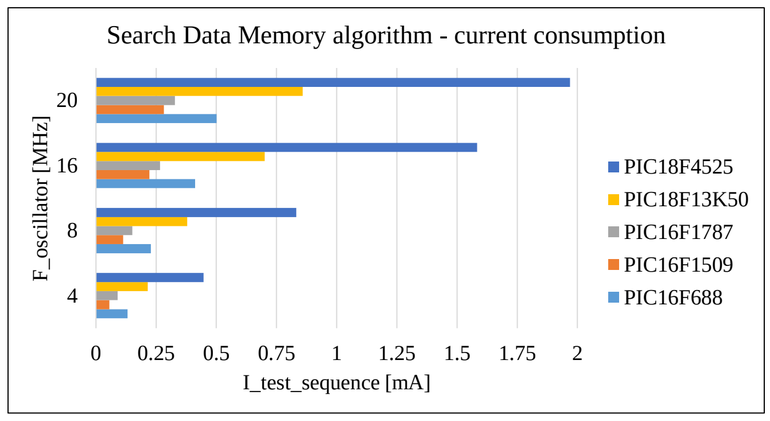
Arithmetic algorithm experimental results



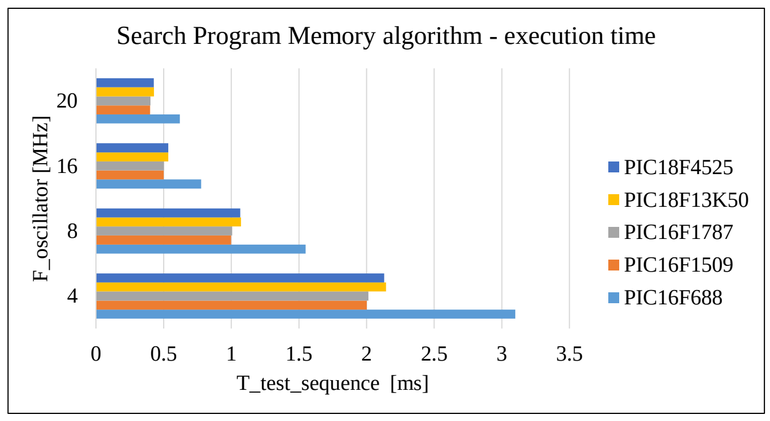


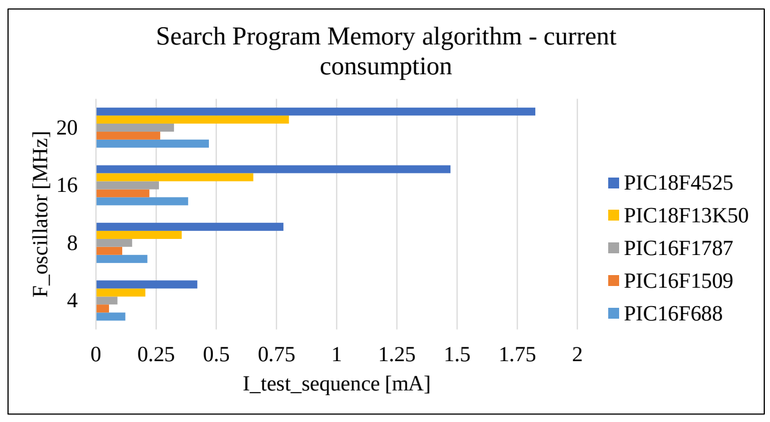
Search Data Memory algorithm experimental results





Search Data Program algorithm experimental results





Conclusions

Comparing the time and current consumption results for the five microcontrollers under test, it was observed that the time and power performance varies for each test sequence and for each clock frequency. Some microcontrollers achieved better time/power performance for some algorithms but worst performance for others.

In conclusion, the microcontroller performance is dependent on the application needs of an embedded system. Better time performance can be achieved by sacrificing current consumption and better power performance can be achieved by sacrificing execution time. The experimental results acquired during the experiments offer an overview of the time performance and power performance for five 8-bit PIC microcontrollers in four different scenarios: *Idle, Arithmetic algorithm, Search Data Memory* and *Search Program Memory*.

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