

**Adaptive Filter based on Least Mean Squares – Digital Implementation in C2000 Delfino MCU F28379D LaunchPad development kit and using Automatic Code Generation of PSIM 12**

**Index**

1. Report description.....	2
2. The Simulation.....	2
3. Simulated and experimental results .....	4
4. Conclusions.....	5
5. Reference .....	5

## 1. Report description

One of the novelties onn version 12 of PSIM is the ability of PSIM to generate code for the Texas Instruments F2837x microcontroller (MCU). I consider this novelty as one of the greatest because for me the MCU F28379D is the best option to embed digital control in power electronics application. Having PSIM generating code for the F28379D is really attractive.

The goal of this report is to describe a simple test I did in PSIM 12 to verify the automatic code generation for F28379D. For this purpose, I implemented an adaptive filter based on Least Mean Squares.

The simulation file used in this report is freely available on my webpage <http://busarello.prof.ufsc.br/>.

## 2. The Simulation

The adaptive filter I created in PSIM is similar to that found in example 8.3.2 of [1]. The purpose of adaptive filter is to find the coefficients of an unknown FIR-based filter, as shown in Figure. 1

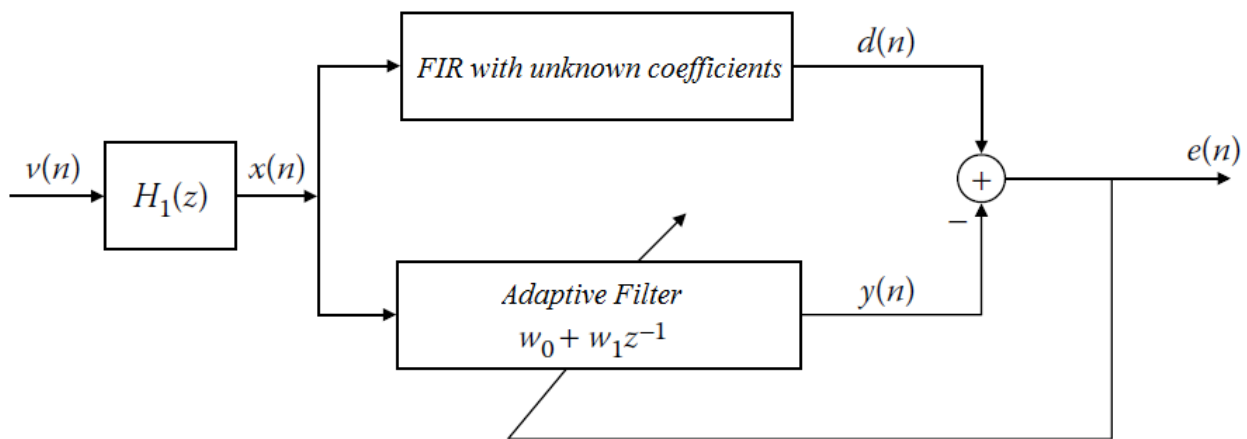


Figure 1: The Adaptive Filter and the FIR with unknown coefficients.

If the adaptive filter is well designed, the final values of  $w_0$  and  $w_1$  will be the same of coefficients of the FIR-based filter, supposing that the FIR is a first order filter. As a result, the error  $e(n)$  is zero in steady-state regime.

The coefficients  $w_0$  and  $w_1$  are updated according to the following equations [1]:

$$\begin{aligned}\mathbf{w}(n+1) &= \mathbf{w}(n) + 2\mu\mathbf{x}(n)[d(n) - \mathbf{x}^T(n)\mathbf{w}(n)] \\ &= \mathbf{w}(n) + 2\mu\mathbf{x}(n)[d(n) - \mathbf{w}^T(n)\mathbf{x}(n)] \\ &= \mathbf{w}(n) + 2\mu e(n)\mathbf{x}(n)\end{aligned}$$

Figure 2 shows the simulation circuit of the adaptive filter.

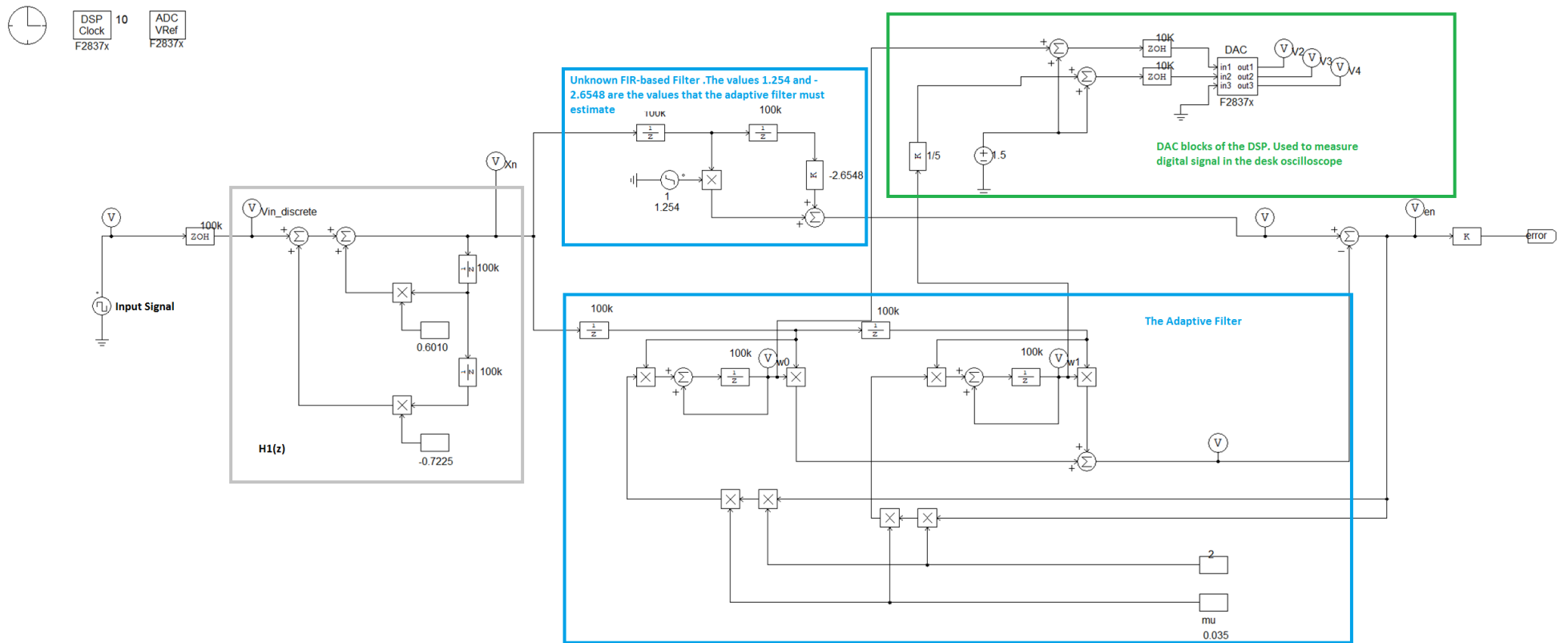


Figure 2: The simulated circuit.

### 3. Simulated and experimental results

Figure 3 presents the coefficients  $w_0$  and  $w_1$  during initialization. Notice that the simulation and experimental results are quite similar. In the experimental result, there are indicators of the ground. Since the DAC of the MCU 28379D has range from 0 to 3V, I had to scale/offset the signals in order to visualize them in the oscilloscope.

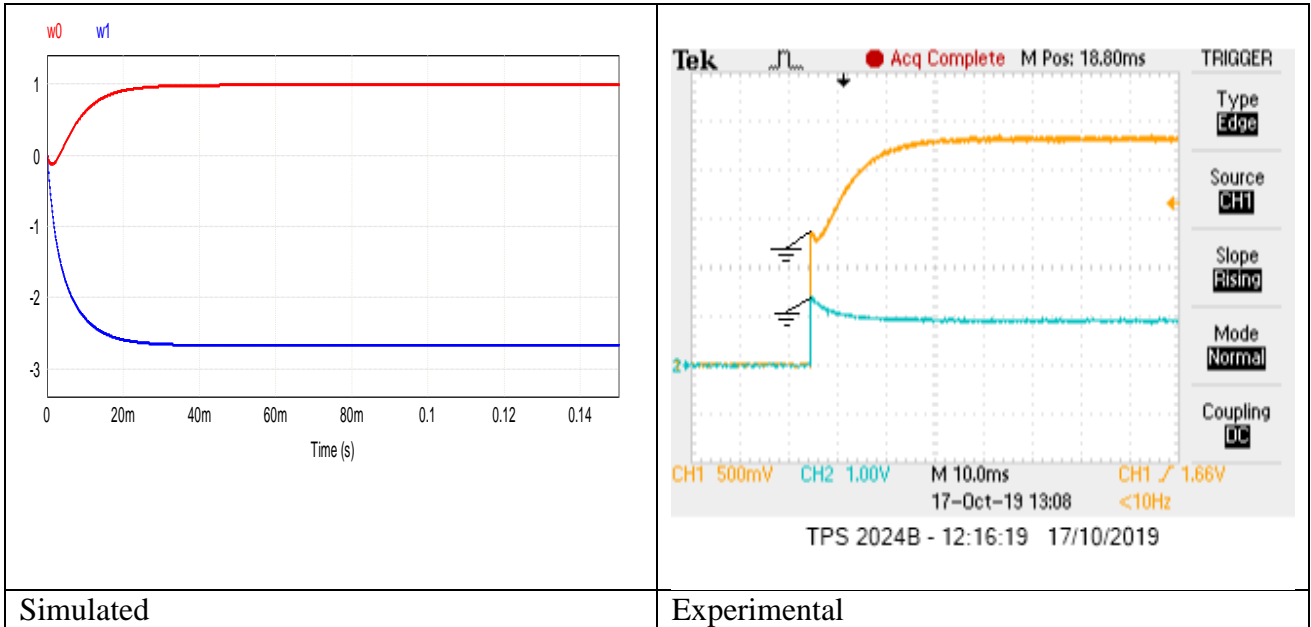


Figure 3: The coefficients  $w_0$  and  $w_1$  during initialization.

Figure 4 presents the coefficients  $w_0$  and  $w_1$  during a transition from 1 to 1.254 in the coefficient of the unknown FIR-based filter.

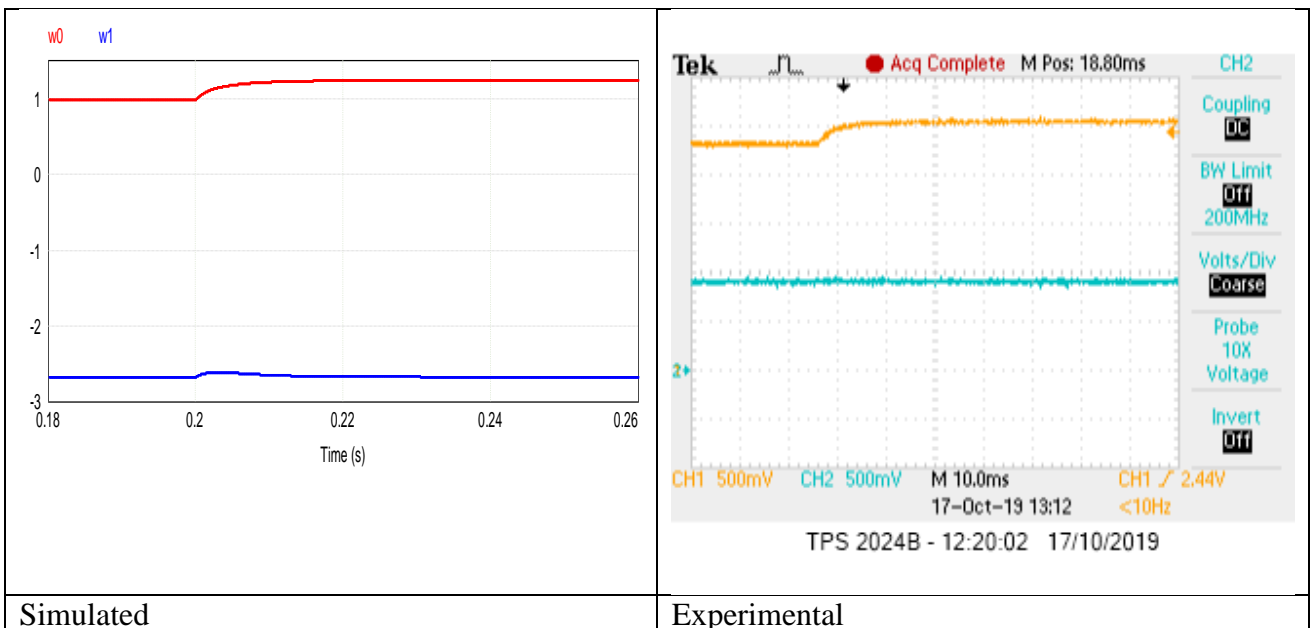


Figure 4: The coefficients  $w_0$  and  $w_1$  during a transition from 1 to 1.254 in the coefficient of the unknown FIR-based filter.

Figure 5 presents the error signal (in the experimental result, the error was multiplied by 15 for better visualization in the oscilloscope).

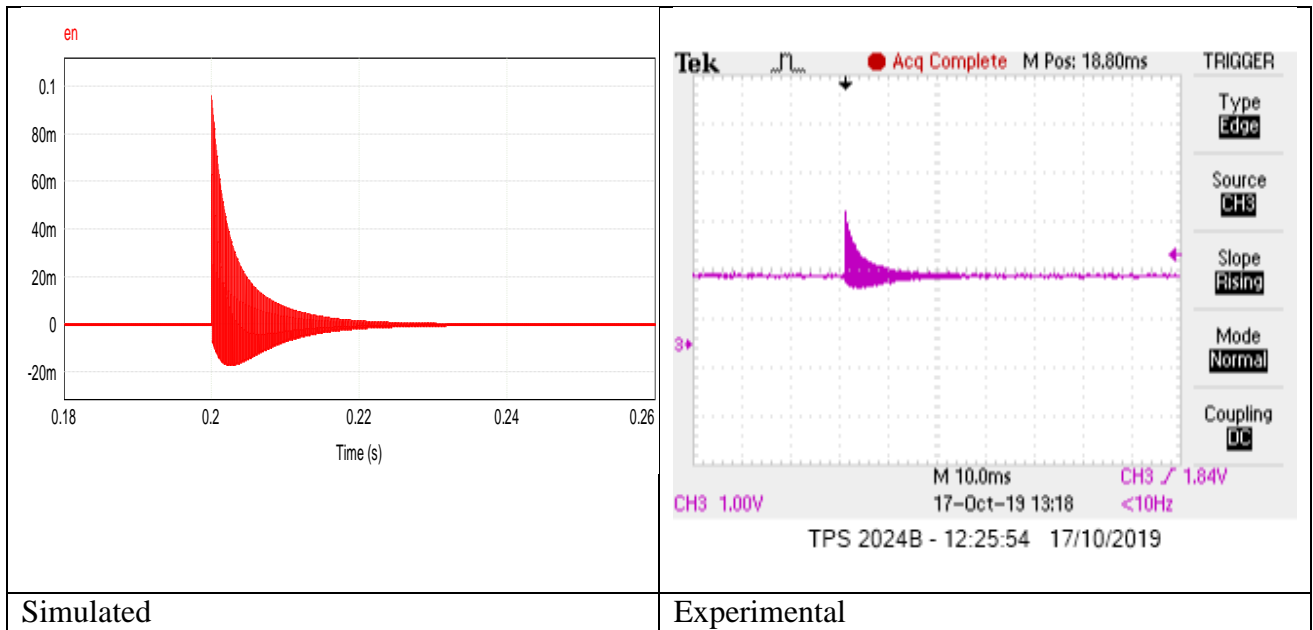


Figure 5: the error signal (in the experimental result, the error was multiplied by 15 for better visualization in the oscilloscope).

Figure 6 shows a picture of the C2000 Delfino MCU F28379D LaunchPad development kit.

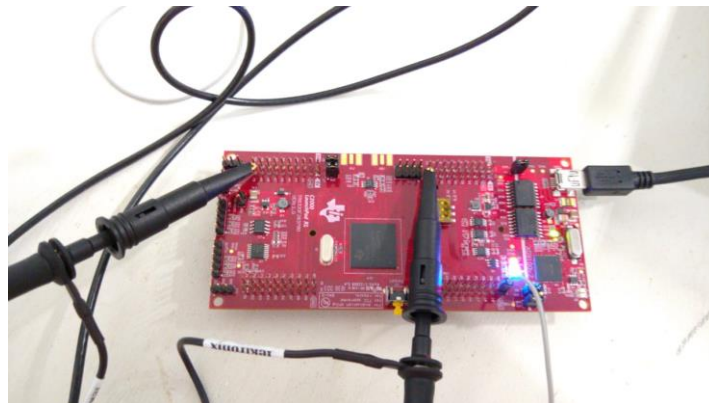


Figure 6: A picture of the C2000 Delfino MCU F28379D LaunchPad development kit

## 4. Conclusions

The experimental results collected in the Texas Instruments F2837x microcontroller (MCU) and programmed with automatic code generation of PSIM 12 show very close similarities related to the simulation. Therefore, using PSIM 12 to generate code for such MCU is advantageous, save a lot of time and it is trustful.

## 5. Reference

[1] Alexander D Poularikas. "Adaptive Filtering: Fundamentals of Least Mean Squares with MATLAB". CRC Press Published September 26, 2014 Reference - 363 Pages.